DSA SUBMITTAL

DSA Appl #03-123641

Arroyo HS - New Theater & Administration Building

4921 Cedar Ave., El Monte, CA 91732

3361008100

El Monte Union High School District



March 31, 2025

HMC Architects

SEALS PAGE

1.01 DESIGN PROFESSIONALS OF RECORD

A. Architect:
1. **Virginia Elaine Marquardt**
2. **#C-33423**



STATEMENT OF GENERAL CONFORMANCE

Application No.: 03-123641

File No.: 19-H10

The specification sections identified as follows:

☒ All section indicated as prepared by other design professionals of record

have been prepared by other design professionals or consultants who are licensed and authorized to prepare such drawings (plans) in this state. They have been examined by me for:

1) Design intent and appear to meet the appropriate requirements of Title 24, California Code of Regulations and the project specifications prepared by me, and

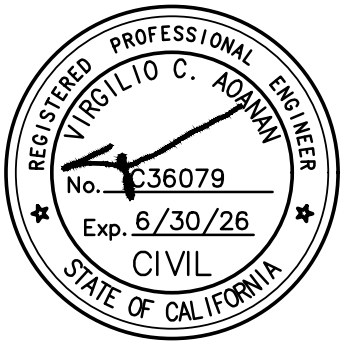
2) Coordination with my drawings (plans) and specifications and are acceptable for incorporation into the construction of this project.

Per Title 24, Part 1, Section 4-316(b): This Statement of General Conformance shall not be construed as relieving me of my rights, duties, and responsibilities under Sections 17302 and 81138 of the Education Code and Sections 4-336, 4-341 and 4-344 of Title 24, Part 1.

Signature		Date
		03-31-2025
Virginia E. Marquardt	C-33423	06-30-2025
Printed Name	License Number	Expiration Date

3. Responsible for Divisions 01-49 Sections except where indicated as prepared by other design professionals of record.

B. Civil Engineer:
1. **Virgilio C. Aoanan**
2. **#C36079**



IDENTIFICATION STAMP
DIV. OF THE STATE ARCHITECT
APP: 03-123641 INC:
REVIEWED FOR
SS ☑ FLS ☑ ACS ☑
DATE: 10/15/2025

3. Responsible for Divisions 02, 31, 32 and 33 except where indicated as prepared by other design professionals or record.

C. Landscape Architect:
1. **Hongjoo Kim**
2. **#5087**

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for CSULB College of Business Addition & Renovation.
Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.



3. Responsible for Divisions 01 and 32 except where indicated as prepared by other design professionals or record.

D. Structural Engineer:
   1. **Robert H. Randall**
   2. **#S4892**



3. Responsible for Divisions 03 and 05 except where indicated as prepared by other design professionals or record.

E. Fire-Alarm Engineer:
   1. **Jorge Velasco**
   2. **#**92448

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for CSULB College of Business Addition & Renovation.
Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

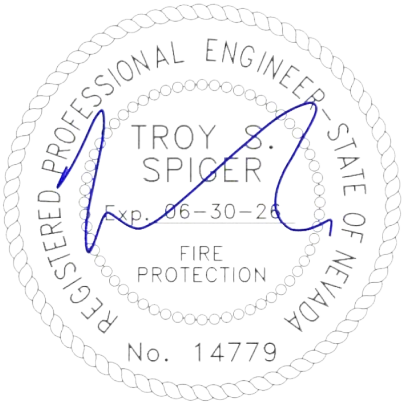
NICET BOX

Jorge Velasco, CET
FIRE ALARM SYSTEMS
LEVEL III
NICET #92448
EXPIRES 12-1-2026



3. Responsible for Divisions and 28 except where indicated as prepared by other design professionals or record.

F. Fire-Sprinkler Engineer:
   1. **Troy S. Spiger**
   2. **#FP1552**



3. Responsible for Division 21 except where indicated as prepared by other design professionals or record.

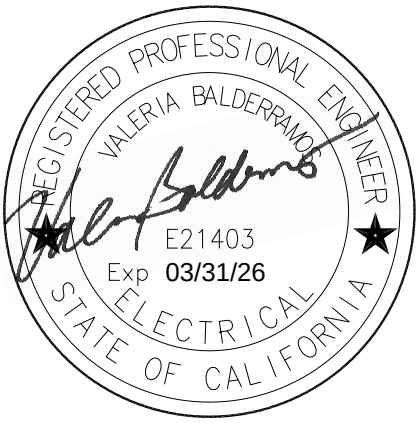
G. HVAC Engineer:
   1. Chi Kuen Chan
   2. **Insert license #M35338**

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for CSULB College of Business Addition & Renovation.
Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.



3. Responsible for Division 23 except where indicated as prepared by other design professionals or record.

H. Electrical Engineer:
   1. **Valeria Balderramos**
   2. **#E21403**



3. Responsible for Division 26 except where indicated as prepared by other design professionals or record.

I. Plumbing Engineer:
   1. **Jonathan R. Robertson**
   2. **#M35000**

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for CSULB College of Business Addition & Renovation.
Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.



3. Responsible for Division 22 except where indicated as prepared by other design professionals or record.

J. Theater Audo and Visual Engineer:
   1. **Stephen A. Martin**
   2. **#E12022**



3. Responsible for Division 27 except where indicated as prepared by other design professionals or record.

END OF DOCUMENT

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for CSULB College of Business Addition & Renovation.
Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

TABLE OF CONTENTS

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

AS PROVIDED BY OWNER

DIVISION 01 - GENERAL REQUIREMENTS

01 10 00 - SUMMARY
01 25 00 - SUBSTITUTION PROCEDURES
01 26 00 - CONTRACT MODIFICATION PROCEDURES
01 26 73 - DSA CONSTRUCTION CHANGE DOCUMENT PROCEDURES
01 29 00 - PAYMENT PROCEDURES
01 31 00 - PROJECT MANAGEMENT AND COORDINATION
01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION
01 33 00 - SUBMITTAL PROCEDURES
01 40 00 - QUALITY REQUIREMENTS
01 42 00 - REFERENCES
01 43 39.16 - INTEGRATED EXTERIOR MOCKUPS
01 50 00 - TEMPORARY FACILITIES AND CONTROLS
01 56 39 - TREE AND PLANT PROTECTION
01 60 00 - PRODUCT REQUIREMENTS
01 73 00 - EXECUTION
01 73 29 - CUTTING AND PATCHING
01 77 00 - CLOSEOUT PROCEDURES
01 78 23 - OPERATION AND MAINTENANCE DATA
01 78 36 - WARRANTIES
01 78 39 - PROJECT RECORD DOCUMENTS
01 81 13.71 - SUSTAINABLE DESIGN REQUIREMENTS - CALGREEN NON-RESIDENTIAL
01 81 13.81 - SUSTAINABLE DESIGN REQUIREMENTS - CHPS

DIVISION 02 - EXISTING CONDITIONS

02 41 16 - DEMOLITION

DIVISION 03 - CONCRETE

03 15 00 - CONCRETE ACCESSORIES
03 30 00 - CAST-IN-PLACE CONCRETE
03 35 03 - CONCRETE SLAB FINISHING
03 35 43 - POLISHED CONCRETE FINISHING

DIVISION 04 - MASONRY

04 21 13.23 - SURFACE-BONDED BRICK MASONRY

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

DIVISION 05 - METALS

05 12 00 - STRUCTURAL STEEL FRAMING
05 12 50 - BUCKLING RESTRAINED BRACES
05 31 00 - STEEL DECKING
05 40 00 - COLD FORMED METAL FRAMING
05 50 00 - METAL FABRICATIONS
05 52 13 - PIPE AND TUBE RAILINGS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

06 10 53 - MISCELLANEOUS ROUGH CARPENTRY
06 16 43 - GYPSUM SHEATHING
06 40 23 - INTERIOR ARCHITECTURAL WOODWORK
06 41 00 - ARCHITECTURAL WOOD CASEWORK

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 05 43 - CLADDING SUPPORT SYSTEMS
07 14 16 - COLD FLUID-APPLIED WATERPROOFING
07 19 00 - WATER REPELLENTS
07 21 00 - THERMAL INSULATION
07 24 19 - WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)
07 25 00 - WEATHER BARRIERS
07 26 00 - VAPOR RETARDERS
07 42 13.23 - METAL COMPOSITE MATERIAL WALL PANELS
07 42 46.16 - FIBER CEMENT WALL PANELS
07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING
07 60 00 - FLASHING AND SHEET METAL
07 65 00 - FLEXIBLE FLASHING
07 71 00 - ROOF SPECIALTIES
07 71 29 - MANUFACTURED ROOF EXPANSION JOINTS
07 72 00 - ROOF ACCESSORIES
07 92 00 - JOINT SEALANTS
07 95 00 - EXPANSION CONTROL

DIVISION 08 - OPENINGS

08 11 13 - HOLLOW METAL DOORS AND FRAMES
08 14 16 - FLUSH WOOD DOORS
08 31 13 - ACCESS DOORS AND FRAMES
08 33 23 - OVERHEAD COILING DOORS
08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS
08 44 00 - CURTAIN WALL AND GLAZED ASSEMBLIES
08 71 00 - DOOR HARDWARE
08 81 00 - GLASS GLAZING
08 83 00 - MIRRORS

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

DIVISION 09 - FINISHES

09 05 61.13 - MOISTURE VAPOR EMISSION CONTROL
09 22 16 - NON-STRUCTURAL METAL FRAMING
09 24 00 - PORTLAND CEMENT PLASTERING
09 29 00 - GYPSUM BOARD
09 30 00 - TILING
09 51 13 - ACOUSTICAL PANEL CEILINGS
09 64 56 - RESILIENT STAGE FLOOR
09 65 00 - RESILIENT FLOORING
09 65 13 - RESILIENT BASE AND ACCESSORIES
09 68 13 - TILE CARPETING
09 72 00 - WALL COVERINGS
09 81 00 - ACOUSTIC INSULATION
09 84 33 - SOUND-ABSORBING WALL UNITS
09 84 36 - SOUND-ABSORBING CEILING UNITS
09 91 00 - PAINTING

DIVISION 10 - SPECIALTIES

10 12 00 - DISPLAY CASES
10 14 00 - SIGNAGE
10 14 19 - DIMENSIONAL LETTER SIGNAGE
10 21 13 - TOILET COMPARTMENTS
10 22 39.13 - FOLDING GLASS-PANEL PARTITIONS
10 28 00 - TOILET ACCESSORIES
10 44 00 - FIRE PROTECTION SPECIALTIES
10 51 13 - METAL LOCKERS
10 81 13 - BIRD CONTROL DEVICES

DIVISION 11 - EQUIPMENT

11 12 33.21 - SWING ARM BARRIER GATES
11 61 23 - STAGE EXTENSION PLATFORMS
11 61 33 - THEATRICAL RIGGING
11 66 43 - INTERIOR SCOREBOARDS

DIVISION 12 - FURNISHINGS

12 24 13 - ROLLER WINDOW SHADES
12 36 00 - COUNTERTOPS
12 36 16 - METAL COUNTERTOPS
12 52 19 - UPHOLSTERED SEATING
12 61 00 - FIXED AUDIENCE SEATING

DIVISION 13 - SPECIAL CONSTRUCTION

NOT APPLICABLE

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

DIVISION 14 - CONVEYING EQUIPMENT

14 42 00 - WHEELCHAIR LIFTS

DIVISION 21 - FIRE SUPPRESSION

21 12 00 - FIRE SUPPRESSION STANDPIPES
21 13 13 - WET-PIPE SPRINKLER SYSTEMS
21 30 00 - ELECTRIC-DRIVE, VERTICAL IN-LINE FIRE PUMPS

DIVISION 22 - PLUMBING

22 05 00 - BASIC PLUMBING MATERIALS AND METHODS
22 05 48 - VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT
22 05 49 - SEISMIC RESTRAINT FOR PLUMBING PIPING AND EQUIPMENT
22 05 93 - PLUMBING TESTING, ADJUSTING AND BALANCING
22 07 00 - PLUMBING INSULATION
22 10 00 - PLUMBING PIPING, VALVES AND SPECIALTIES
22 34 00 - DOMESTIC HOT WATER HEATING EQUIPMENT
22 40 00 - PLUMBING FIXTURES

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING(HVAC)

23 05 00 - BASIC HVAC MATERIALS AND METHODS
23 05 48 - VIBRATION ISOLATION FOR PIPING DUCTWORK AND EQUIPMENT
23 05 49 - SEISMIC RESTRAINT FOR PIPING DUCTWORK AND EQUIPMENT
23 05 93 - TESTING ADJUSTING AND BALANCING
23 07 13 - DUCT INSULATION
23 07 19 - HVAC PIPING INSULATION
23 09 00 - BUILDING AUTOMATION SYSTEM (BAS) CONTROLS
23 09 02 - VARIABLE FREQUENCY DRIVES (VFD)
23 23 00 - REFRIGERANT PIPING SYSTEMS
23 31 13 - AIR DISTRIBUTION
23 34 16 - INLINE FANS
23 73 14 - DEDICATED OUTSIDE AIR HANDLING UNITS
23 74 13 - PACKAGED HVAC UNITS (UP TO 25 TONS)
23 81 30 - MINI-SPLIT AIR CONDITIONING UNITS
23 81 45 - SPLIT HEAT PUMP
23 84 13 - HUMIDIFIERS

DIVISION 25 - INTEGRATED AUTOMATION

NOT APPLICABLE

DIVISION 26 - ELECTRICAL

26 00 00 - BASIC ELECTRICAL REQUIREMENTS
26 05 13 - MEDIUM-VOLTAGE CABLES AND ACCESSORIES
26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
26 05 53 - IIDENTIFICATION FOR ELECTRICAL SYSTEMS
26 05 73.13 - SHORT CIRCUIT STUDIES
26 05 73.16 - COORDINATION STUDIES
26 05 73.19 - ARC-FLASH HAZARD ANALYSIS
26 09 23 - LIGHTING CONTROL DEVICES
26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS
26 24 13 - SWITCHBOARDS
26 24 16 - PANELBOARDS
26 27 26 - WIRING DEVICES
26 31 00 - PHOTOVOLTAIC COMPONENTS
26 55 61 - THEATRICAL LIGHTING

DIVISION 27 - COMMUNICATIONS

27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS
27 05 26 - GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS
27 05 28 - CONDUIT AND BACK BOXES FOR COMMINCATION SYSTEMS
27 05 30 - HANGERS AND SUPPORTS FOR COMMUNICATION SYSTEM CABLES
27 05 43 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATIONS SYSTEMS
27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS
27 13 00 - COMMUNICATIONS BACKBONE CABLING
27 15 00 - COMMUNICATIONS HORIZONTAL CABLING
27 41 16 - INTEGRATED AUDIOVISUAL SYSTEMS AND EQUIPMENT (GLUMAC)
27 41 16.10 - INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT (VANEKLASEN)
27 51 14 - INTERNET PROTOCOL OVERHEAD PAGING SYSTEM
27 51 56 - ASSISTIVE LISTENING SYSTEM

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS
28 13 00 - CREDENTIALED ACCESS CONTROL MANAGEMENT SYSTEM
28 23 00 - VIDEO SURVEILLANCE
28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

DIVISION 31 - EARTHWORK

31 10 00 - SITE CLEARING
31 22 00 - GRADING
31 22 19 - LANDSCAPE GRADING
31 23 13 - EXCAVATION AND FILL
31 23 16 - EXCAVATION AND FILL FOR PAVING
31 23 19 - EXCAVATION AND FILL FOR STRUCTURES
31 23 23 - EXCAVATION AND FILL FOR UTILITIES
31 23 26 - BASE COURSE

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 12 16 - ASPHALT PAVING
32 12 36 - SEAL BITUMINOUS SURFACING
32 13 13 - SITE CONCRETE WORK
32 13 16 - LANDSCAPE SITE CONCRETE PAVING
32 31 13 - CHAIN LINK FENCES AND GATES
32 31 19.55 - DECORATIVE METAL SECURITY GATES
32 84 00 - LANDSCAPE IRRIGATION
32 91 00 - PLANTING SOIL
32 93 00 - PLANTING

DIVISION 33 - UTILITIES

33 11 00 - SITE WATER DISTRIBUTION UTILITIES
33 30 00 - SITE SANITARY SEWER UTILITIES
33 40 00 - STORM DRAINAGE UTILITIES

DIVISION 34 - TRANSPORTATION

NOT APPLICABLE

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

NOT APPLICABLE

DIVISION 40 - PROCESS INTEGRATION

NOT APPLICABLE

DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT

NOT APPLICABLE

DIVISION 42 - PROCESS HEATING, COOLING, AND DRYING EQUIPMENT

NOT APPLICABLE

DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE EQUIPMENT

NOT APPLICABLE

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

DIVISION 44 - POLLUTION CONTROL EQUIPMENT

NOT APPLICABLE

DIVISION 45 - INDUSTRY-SPECIFIC MANUFACTURING EQUIPMENT

NOT APPLICABLE

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

NOT APPLICABLE

DIVISION 48 - ELECTRICAL POWER GENERATION

NOT APPLICABLE

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Contractor's use of site and premises.
   2. Coordination with occupants.
   3. Work restrictions.
   4. Specification and Drawing conventions.

1.02 CONTRACTOR'S USE OF SITE AND PREMISES

A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

B. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

C. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
   1. Driveways, Walkways, and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

1.03 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site and existing building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.

B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1.04 WORK RESTRICTIONS

A. Comply with restrictions on construction operations.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed utility interruptions.
   2. Obtain Owner's written permission before proceeding with utility interruptions.

C. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
   1. Notify Owner not less than two days in advance of proposed disruptive operations.
   2. Obtain Owner's written permission before proceeding with disruptive operations.

1.05 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
   2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
   3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
   4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.

C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

1.02 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.03 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
      b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. Certificates and qualification data, where applicable or requested.
      g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
      h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

i. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
j. Cost information, including a proposal of change, if any, in the Contract Sum.
k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.04 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.05 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.06 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Substitution request is fully documented and properly submitted.
c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Architect.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Substitution request is fully documented and properly submitted.
e. Requested substitution will not adversely affect Contractor's construction schedule.
f. Requested substitution has received necessary approvals of authorities having jurisdiction.
g. Requested substitution is compatible with other portions of the Work.
h. Requested substitution has been coordinated with other portions of the Work.
i. Requested substitution provides specified warranty.
j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.02 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.03 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
      e. Quotation Form: Use forms acceptable to Architect.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.04 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor..

1.05 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive directing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
   1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 26 73 – DSA CONSTRUCTION CHANGE DOCUMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing DSA Construction Change Documents for modifications of portions of the project affecting the Structural Safety, Access Compliance, and Fire and Life Safety.

B. Related Sections:
1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling contract modifications not affecting the Structural Safety, Access Compliance, and Fire and Life Safety portions of the project.

1.02 DEFINITIONS

A. DSA: Division of the State Architect.

1.03 CONSTRUCTION CHANGE DOCUMENT

A. Construction Change Document: Architect will submit a Construction Change Document on DSA Form 140 Application for Approval of Construction Change Document to DSA. Upon DSA approval of a Construction Change Document, Architect will notify Contractor to proceed with the change in the Work, for subsequent inclusion in a Change Order.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.02 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
   1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
   2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
   1. Arrange schedule of values consistent with format of AIA Document G703.
   2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
   3. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
      a. Differentiate between items stored on-site and items stored off-site.
   4. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
   5. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.03 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Application for Payment Forms: Use form designated by Architect as form for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
   1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
   2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
   3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

E. Transmittal: Submit signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien in accordance with Owner's requirements and as follows:
   1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
   2. When an application shows completion of an item, submit conditional final or full waivers.
   3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
   4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
   5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
   1. List of subcontractors.
   2. Schedule of values.
   3. Contractor's construction schedule (preliminary if not final).
   4. Products list (preliminary if not final).
   5. Sustainable design action plans, including preliminary project materials cost data.
   6. Schedule of unit prices.
   7. Submittal schedule (preliminary if not final).

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

8. List of Contractor's staff assignments.
9. List of Contractor's principal consultants.
10. Copies of building permits.
11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
12. Initial progress report.
13. Report of preconstruction conference.
14. Certificates of insurance and insurance policies.
15. Performance and payment bonds.
16. Data needed to acquire Owner's insurance.

H. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706.
5. AIA Document G706A.
6. AIA Document G707.
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General coordination procedures.
   2. Coordination drawings.
   3. RFIs.
   4. Project meetings.

1.02 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.03 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
      a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
      b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

1.04 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
   1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
   1. Owner name.
   2. Owner's Project number.
   3. Name of Architect.
   4. Architect's Project number.
   5. Date.
   6. Name of Contractor.
   7. RFI number, numbered sequentially.
   8. RFI subject.
   9. Specification Section number and title and related paragraphs, as appropriate.
   10. Drawing number and detail references, as appropriate.
   11. Field dimensions and conditions, as appropriate.
   12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   13. Contractor's signature.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
   a. Requests for approval of submittals.
   b. Requests for approval of substitutions.
   c. Requests for approval of Contractor's means and methods.
   d. Requests for coordination information already indicated in the Contract Documents.
   e. Requests for adjustments in the Contract Time or the Contract Sum.
   f. Requests for interpretation of Architect's actions on submittals.
   g. Incomplete RFIs or inaccurately prepared RFIs.
2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within five days of receipt of the RFI response.

E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

1.05 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Responsibilities and personnel assignments.
   b. Tentative construction schedule.
   c. Critical work sequencing and long lead items.
   d. Designation of key personnel and their duties.
   e. Lines of communications.
   f. Procedures for RFIs.
   g. Procedures for testing and inspecting.
   h. Procedures for processing Applications for Payment.
   i. Distribution of the Contract Documents.
   j. Submittal procedures.
   k. Sustainable design requirements.
   l. Preparation of Record Documents.
   m. Use of the premises.
   n. Work restrictions.
   o. Working hours.
   p. Owner's occupancy requirements.
   q. Responsibility for temporary facilities and controls.
   r. Procedures for moisture and mold control.
   s. Procedures for disruptions and shutdowns.
   t. Construction waste management and recycling.
   u. Parking availability.
   v. Office, work, and storage areas.
   w. Equipment deliveries and priorities.
   x. First aid.
   y. Security.
   z. Progress cleaning.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Sustainable Design Requirements Coordination Meetings: Schedule and conduct a sustainable design coordination conference before starting construction, at a time convenient to Owner Architect, and Contractor. Schedule progress meetings at quarterly intervals during construction.
1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:
   a. Sustainable design Project checklist.
   b. General requirements for sustainable design-related procurement and documentation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

c. Project closeout requirements and sustainable design certification procedures.
d. Construction waste management.
e. Construction operations and sustainable design requirements and restrictions.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

E. Progress Meetings: Conduct progress meetings at regular intervals.
1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
1) Review schedule for next period.
b. Review present and future needs of each entity present, including the following:
1) Interface requirements.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2) Sequence of operations.
3) Resolution of BIM component conflicts.
4) Status of submittals.
5) Status of sustainable design documentation.
6) Deliveries.
7) Off-site fabrication.
8) Access.
9) Site use.
10) Temporary facilities and controls.
11) Progress cleaning.
12) Quality and work standards.
13) Status of correction of deficient items.
14) Field observations.
15) Status of RFIs.
16) Status of Proposal Requests.
17) Pending changes.
18) Status of Change Orders.
19) Pending claims and disputes.
20) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Contractor's Construction Schedule.

1.02 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
   1. Working electronic copy of schedule file.
   2. PDF file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

C. Construction Schedule Updating Reports: Submit with Applications for Payment.

1.03 COORDINATION

A. Coordinate Contractor's Construction Schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from entities involved.
   2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.04 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
   1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
   2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
      a. Securing of approvals and permits required for performance of the Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Temporary facilities.
c. Construction of mock-ups, prototypes and samples.
d. Owner interfaces and furnishing of items.
e. Interfaces with Separate Contracts.
f. Regulatory agency approvals.
g. Punch list.

3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.

C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

D. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate Final Completion percentage for each activity.

E. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.05 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
   1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Submittal schedule requirements.
   2. Administrative and procedural requirements for submittals.

1.02 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.03 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1.04 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:
   1. Project name.
   2. Date.
   3. Name of Architect.
   4. Name of Contractor.
   5. Name of firm or entity that prepared submittal.
   6. Names of subcontractor, manufacturer, and supplier.
   7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
   8. Category and type of submittal.
   9. Submittal purpose and description.
   10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.05 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.06 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.
      f. Application of testing agency labels and seals.
      g. Notation of coordination requirements.
      h. Availability and delivery time information.
   4. For equipment, include the following in addition to the above, as applicable:
      a. Wiring diagrams that show factory-installed wiring.
      b. Printed performance curves.
      c. Operational range diagrams.
      d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
   5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
   1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
   2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Project name and submittal number.
b. Generic description of Sample.
c. Product name and name of manufacturer.
d. Sample source.
e. Number and title of applicable Specification Section.
f. Specification paragraph number and generic name of each item.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   a. Number of Samples: Submit full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
   a. Number of Samples: Submit three sets of Samples. Architect will retain one Sample set; remainder will be returned.Retain one returned Sample set as a project record Sample.
      1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

F. Certificates:
   1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
   2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
   3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
   4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
   5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
   6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

G. Test and Research Reports:
   1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
   2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
   4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   a. Name of evaluation organization.
   b. Date of evaluation.
   c. Time period when report is in effect.
   d. Product and manufacturers' names.
   e. Description of product.
   f. Test procedures and results.
   g. Limitations of use.

1.07 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.08 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
   1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.09 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will return without review or discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned or discarded by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Related Sections:
   1. Section 01 43 39.16 "Integrated Exterior Mockups" for integrated exterior mockup assembly requirements.

C. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
   2. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.02 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
   1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   1. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.
   2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
   3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall have the same meaning as testing agency.

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.03 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Statement: Submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.04 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.05 ACTION SUBMITTALS

A. Mockup Shop Drawings: For laboratory mockups.
   1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
   2. Indicate manufacturer and model number of individual components.
   3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.06 INFORMATIONAL SUBMITTALS

A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

C. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.07 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Statement on condition of substrates and their acceptability for installation of product.
2. Statement that products at Project site comply with requirements.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
   1. Statement that equipment complies with requirements.
   2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   3. Other required items indicated in individual Specification Sections.

1.08 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

H. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
      d. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
   2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups of size indicated.
   2. Build mockups in location indicated or, if not indicated, as directed by Architect.
   3. Notify Architectseven days in advance of dates and times when mockups will be constructed.
   4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
   5. Demonstrate the proposed range of aesthetic effects and workmanship.
   6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of each mockup.
   7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
   8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   10. Demolish and remove mockups when directed unless otherwise indicated.

1.09 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Engage a qualified testing agency to perform quality-control services.
   a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Contractor-Engaged Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   6. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.10 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.01 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.02 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.03 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 43 39.16 - INTEGRATED EXTERIOR MOCKUPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Related Sections:
   1. Division 01 Section "Quality Requirements" for mockups not addressed in this section and additional requirements that apply to this section.

1.02 DEFINITIONS

A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies, with cutaways enabling inspection of concealed portions of the Work.
   1. Include each system, assembly, component, and part of the exterior wall to be constructed for the Project. Colors of components shall be those selected by the Architect

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, testing and inspecting agency representative, and installers of major systems whose Work is included in integrated exterior mockups.
   2. Review locations and extent of mockups.
   3. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and maintain schedule for the Work.

1.04 ACTION SUBMITTALS

A. Delegated Design Submittal: For temporary structural supports for mockups not attached to building structure, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 QUALITY ASSURANCE

A. Build mockups to do the following:
   1. Verify selections made under Sample submittals.
   2. Demonstrate aesthetic effects.
   3. Demonstrate the qualities of products and workmanship.
   4. Demonstrate acceptable coordination between components and systems.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.
   1. Build mockups of size indicated.
   2. Build mockups in location indicated or, if not indicated, as directed by Architect.
   3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
   4. Demonstrate the proposed range of aesthetic effects and workmanship.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed unless otherwise indicated.

C. Notifications:
   1. Notify Architectseven days in advance of the dates and times when mockups will be constructed.
   2. Allow seven days for initial review and each re-review of each mockup.

D. Approval: Obtain Architect's approval of mockups before starting fabrication or construction of corresponding Work.
   1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 COORDINATION

A. Coordinate schedule for construction of mockups, so construction and review of mockups do not impact Project schedule.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design support structure for free-standing mockups.

B. Structural Performance:
   1. Seismic Performance: Mockups and support structure to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
   2. Wind Loads: As indicated on Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 INTEGRATED EXTERIOR MOCKUPS

A. Construct integrated exterior mockups as indicated on Drawings. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

B. Design and construct foundation and superstructure to support free-standing integrated exterior mockups.

C. Build integrated exterior mockups using installers and construction methods that will be used in completed construction.

D. Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.

E. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.

F. Retain approved mockups constructed in place. Incorporate fully into the Work.

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.02 USE CHARGES

A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.

1.03 INFORMATIONAL SUBMITTALS

A. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

B. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

C. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
   1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
   2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
   3. Indicate methods to be used to avoid trapping water in finished work.

D. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
   1. Locations of dust-control partitions at each phase of work.
   2. HVAC system isolation schematic drawing.
   3. Location of proposed air-filtration system discharge.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

4. Waste-handling procedures.
5. Other dust-control measures.

E. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:
1. Methods used to meet the goals and requirements of the Owner.
2. Concrete cutting method(s) to be used.
3. Location of construction devices on the site.
4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.

1.04 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and the California Building Code.

1.05 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

3.02 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.
   1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

C. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

D. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.03 SUPPORT FACILITIES INSTALLATION

A. Traffic Controls: Comply with requirements of authorities having jurisdiction.
   1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
   2. Maintain access for fire-fighting equipment and access to fire hydrants.

B. Parking: Provide temporary offsite or use designated areas of Owner's existing parking areas, if authorized, for construction personnel.

C. Storage and Staging: Provide temporary offsite area or use designated areas of Project site for storage and staging needs.

D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
   a. Provide temporary, directional signs for construction personnel and visitors.
3. Maintain and touch up signs, so they are legible at all times.

F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.
1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
4. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

G. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

H. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
   1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

I. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
   1. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
   2. Insulate partitions to control noise transmission to occupied areas.
   3. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
   4. Protect air-handling equipment.
   5. Provide walk-off mats at each entrance through temporary partition.

J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
   1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
   2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
   3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
   4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.05 MOISTURE AND MOLD CONTROL

A. Moisture and Mold Protection: Protect stored materials and installed Work.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
   1. Protect porous materials from water damage.
   2. Protect stored and installed material from flowing or standing water.
   3. Keep porous and organic materials from coming into prolonged contact with concrete.
   4. Remove standing water from decks.
   5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
   1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
   2. Keep interior spaces reasonably clean and protected from water damage.
   3. Periodically collect and remove waste containing cellulose or other organic matter.
   4. Discard or replace water-damaged material.
   5. Do not install material that is wet.
   6. Discard and replace stored or installed material that begins to grow mold.
   7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
   1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
   2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
   3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
      a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
      b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
      c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.06 OPERATION, TERMINATION, AND REMOVAL

A. Maintenance: Maintain facilities in good operating condition until removal.
   1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

B. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 56 39 - TREE AND PLANT PROTECTION

PART 1 – GENERAL

1.1 SUMMARY

A. The scope of work includes all labor, materials, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with protection of existing trees and other plants as shown on the drawings and as specified herein.

1. Provide preconstruction evaluations
2. Provide tree and plant protection fencing.
3. Provide protection of root zones and above ground tree and plants
4. Provide pruning of existing trees and plants.
5. Coordinate with the requirements of Section Planting Soil for modifications to the soil within the root zone of existing trees and plants.
6. Provide all insect and disease control.
7. Provide maintenance of existing trees and plants including irrigation during the construction period as recommended by the arborist report.
8. Provide maintenance of existing trees and plants including irrigation during the post construction plant maintenance period.
9. Remove tree protection fencing and other protection from around and under trees and plants.
10. Clean up and disposal of all excess and surplus material.

1.2 CONTRACT DOCUMENTS

A. Shall consist of specifications and general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

B. It is the intent of this section that the requirements apply to all sections of the project specification such that any subcontractor must comply with the restrictions on work within designated Tree and Plant Protection Areas.

1.3 RELATED DOCUMENTS AND REFERENCES

A. Related Documents:
1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section.
a. Section 32 9300 - Planting
b. Section 32 91 00 - Planting Soil
c. Section 32 84 00 - Irrigation

B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

1. ANSI A 300 (Part 5) – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current editions.
2. Pruning practices shall conform with recommendations “Structural Pruning: A Guide For The Green Industry”; Published by Urban Tree Foundation, Visalia, California; most current edition.
3. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign Il, most current edition.

1.4 VERIFICATION

A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner’s Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner’s Representative.

1.5 PERMITS AND REGULATIONS

A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner’s Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner’s Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

A. The Contractor shall protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

1.7 CHANGES IN THE WORK

A. The Owner’s Representative may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work

involved.

1.8 CORRECTION OF WORK

A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest possible time that can be coordinated with other work and seasonal weather demands**.**

1.9 DEFINITIONS

All terms in this specification shall be as defined in the "Glossary of Arboricultural Terms" or as modified below.

A. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.

B. Reasonable and reasonably: When used in this specification is intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that plants are not free of defects, and that plant conditions change with time. This specification also recognizes that some decisions cannot be totally based on measured findings and that profession judgment is required. In cases of differing opinion, the Owner's Representative expert shall determine when conditions within the plant are judged as reasonable.

C. Shrub: Woody plants with mature height approximately less than 25 feet.

D. Tree and Plant Protection Area: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and defined by a circle centered on the trunk with each tree with a radius equal to the clown dripline unless otherwise indicated by the owner's representative.

E. Tree: Single and multi-stemmed plants, including palms with anticipated mature height approximately greater than 25 feet or any plant identified on the plans as a tree.

1.10 SUBMITTALS

A. ARBORIST REPORT: Prior to the start of construction, submit, for approval by the Owner's Representative, the report of a consulting arborist who is a registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist, which details the following information for all trees to remain within the area designated on the drawings as the Tree and Plant Protection Area. The report shall include the following:
   1. A description of each tree to remain indicating its genus and species, condition including any visible damage to the root system or soil within the root zone, tree diameter at breast height (dbh) and approximate height, size and any visible disease, insect infestations and or branch and trunk structural deficiencies.
   2. The report shall note all trees or parts of trees, which are considered a hazard or significant or extreme risk level. Include the International Society of Arboriculture hazard

evaluation sheet for each tree, which may reasonably be identified as a potential hazard tree.
3. Recommendations as to treatment of all insect, disease and structural problems encountered.
4. Recommendations for fertilizer treatments, if any.
5. A plan of the site showing the location of all trees included in the report.

B. PRODUCT DATA: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval. Provide submittal four weeks before the start of any work at the site.

C. QUALIFICATIONS SUBMITTAL: For each applicable person expected to work on the project, provide copies of the qualifications and experience of the Consulting arborist, proof of either the registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist and any required Herbicide/Pesticide license to the Owner's Representative, for review prior to the start of work.

1.11 OBSERVATION OF THE WORK

A. The Owner's Representative may inspect the work at any time.

1.12 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre - construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.
1. The following Contractors shall attend the preconstruction conference:
a. General Contractor.
b. Consulting Arborist.
c. Subcontractor assigned to install Tree and Plant Protection measures.
d. Earthwork Contractor.
e. All site utility Contractors that may be required to dig or trench into the soil.
f. Landscape subcontractor.
g. Irrigation subcontractor

B. Prior to this meeting, mark all trees and plants to remain and or be removed as described in this specification for review and approval by the Owner's Representative.

1.13 QUALITY ASSURANCE

A. Contractor qualifications:
1. All pruning, branch tie back, tree removal, root pruning, and fertilizing required by this section shall be performed by or under the direct supervision of ISA Certified Arborist Submit aforementioned individual's qualifications for approval by the Owner's Representative.
2. All applications of pesticide or herbicide shall be performed by a person maintaining a current state license to apply chemical pesticides valid in the jurisdiction of the project. Submit copies of all required state licensing certificates including applicable chemical applicator licenses.

PART 2 – PRODUCTS

2.1 MULCH

A. Mulch shall be coarse, ground, from tree and woody brush sources. The minimum range of fine particles shall be 3/8 inch or less in size and a maximum size of individual pieces shall be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 4 to 8 inches. No more that 25% of the total volume shall be fine particles and no more than 20% of total volume be large pieces.

1. It is understood that Mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.

B. Submit suppliers product data that product meets the requirements and two gallon sample for approval.

2.2 WOOD CHIPS:

A. Wood Chips from an arborist chipping operation with less than 20% by volume green leaves. Chips stockpiled from the tree removal process may be used.

2.3 TREE PROTECTION FENCING:

A. PLASTIC MESH FENCE: Heavy - duty orange plastic mesh fencing fabric 48 inches wide. Fencing shall be attached to metal "U" or "T" post driven into the ground of sufficient depth to hold the fabric solidly in place with out sagging. The fabric shall be attached to the post using attachment ties of sufficient number and strength to hold up the fabric without sagging. The Owner's Representative may request, at any time, additional post, deeper post depths and or additional fabric attachments if the fabric begins to sag, lean or otherwise not present a sufficient barrier to access.

B. CHAIN LINK FENCE: 6 feet tall metal chain link fence set in metal frame panels on movable core drilled concrete blocks of sufficient size to hold the fence erect in areas of existing paving to remain.

C. GATES: For each fence type and in each separate fenced area, provide a minimum of one 3 foot wide gate. Gates shall be lockable. The location of the gates shall be approved by the Owner's Representative.

D. Submit suppliers product data that product meets the requirements for approval.

2.4 TREE PROTECTION SIGN:

A. Heavy-duty cardboard signs, 8.5 inches x 11 inches, white colored background with black 2 inch high or larger letters block letters. The signs shall be attached to the tree protection fence every 50 feet o.c. The tree protection sign shall read "Tree and Plant Protection Area-Keep Out".

2.5 TREE GROWTH REGULATOR (TGR)

A. Cambistat 25C.

B. Submit suppliers product data that product meets the requirements for approval.

2.6 MATTING

A. Matting for vehicle and work protection shall be heavy duty matting designed for vehicle loading over tree roots, Alturnamats as manufactured by Alturnamats, Inc. Franklin, PA 16323 or approved equal.

B. Submit suppliers product data that product meets the requirements for approval.

2.7 GEOGRID

A. Geogrid shall be woven polyester fabric with PVC coating, Uni-axial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, acids.
   1. Geogrid shall be Miragrid 2XT as manufactured by Ten Cate Nicolon, Norcross, GA. http://www.tencate.com or approved equal.

B. Submit suppliers product data that product meets the requirements for approval.

2.8 FILTER FABRIC

A. Filter Fabric shall be nonwoven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.
   1. Mirafi 135 N as manufactured by Ten Cate Nicolon, Norcross, GA. http://www.tencate.com or approved equal.

B. Submit suppliers product data that product meets the requirements for approval.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

A. Examine the site, tree, plant and soil conditions. Notify the Owner's Representative in writing of any conditions that may impact the successful Tree and Plant Protections that is the intent of this section.

3.2 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work.

B. Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades.

C. Coordinate the relocation of any irrigation lines currently present on the irrigation plan, heads or the conduits of other utility lines or structures that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3.3 TREE AND PLANT PROTECTION AREA: The Tree and Plant Protection Area is defined as all areas indicated on the tree protection plan. Where no limit of the Tree and Plant Protection area is defined on the drawings, the limit shall be the drip line (outer edge of the branch crown) of each tree.

3.4 PREPARATION:

A. Prior to the preconstruction meeting, layout the limits of the Tree and Plant Protection Area and then alignments of required Tree and Plant Protection Fencing and root pruning. Obtain the Owner's Representative's approval of the limits of the protection area and the alignment

of all fencing and root pruning.

B. Flag all trees and shrubs to be removed by wrapping orange plastic ribbon around the trunk and obtain the Owner's Representative's approval of all trees and shrubs to be removed prior to the start of tree and shrub removal. After approval, mark all trees and shrubs to be removed with orange paint in a band completely around the base of the tree or shrub 4.5 feet above the ground.

C. Flag all trees and shrubs to remain with white plastic ribbon tied completely around the trunk or each tree and on a prominent branch for each shrub. Obtain the Owner's Representative's approval of all trees and shrubs to be remain prior to the start of tree and shrub removal.

D. Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, Filter Fabric, silt fence, tree protection signs, Geogrid, Mulch and or Wood Chips as shown on the drawings.

3.5 SOIL MOISTURE

A. Volumetric soil moisture level, in all soils within the Tree and Plant Protection Area shall be maintained above permanent wilt point to a depth of at least 8 inches. No soil work or other activity shall be permitted within the Tree and Plant Protection Area when the volumetric soil moisture is above field capacity. The permanent wilt point and field capacity for each type of soil texture shall be defined as follows (numbers indicate percentage volumetric soil moisture).

Soil type	**Permanent wilt point v/v**	**Field capacity v/v**
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

1. Volumetric soil moisture shall be measured with a digital, electric conductivity meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent meter.

B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend operations until the soil moisture drains to below field capacity.

3.6 ROOT PRUNING:

A. Prior to any excavating into the existing soil grade within 25 feet of the limit of the Tree and Plant Protection Area or trees to remain, root prune all existing trees to a depth of 24 inches below existing grade in alignments following the edges of the Tree and Plant Protection Area or as directed by the Owner's Representative. Root pruning shall be in conformance with ANSI A300 (part 8) latest edition.

1. Using a rock saw, chain trencher or similar trenching device, make a vertical cut within 2 feet of the limit of grading.
2. After completion of the cut, make clean cuts with a lopper, saw or pruner to remove all torn root ends on the tree side of the excavation, and backfill the trench immediately with existing soil, filling all voids.

3.7 INSTALLATION OF GEOGRIDS, FILTER FABRIC, MATTING, WOOD CHIPS AND OR MULCH

A. Install Geogrids, Filter Fabric, matting, Wood Chips and or Mulch in areas and depths shown on the plans and details or as directed by the Owner's representative. In general it is the intent of this specification to provide the following levels of protection:
   1. All areas within the Tree and Plant Protection area provide a minimum of 5 inches of Wood Chips or Mulch.
   2. Areas where foot traffic or storage of lightweight materials is anticipated to be unavoidable provide a layer of Filter Fabric under the 5 inches of Wood Chips or Mulch.
   3. Areas where occasional light vehicle traffic is anticipated to be unavoidable provide a layer of Geogrids under 8 inches of Wood Chips or Mulch.
   4. Areas where heavy vehicle traffic is unavoidable provide a layer of Geogrids under 8 - 12 inches of Wood Chips or Mulch and a layer of matting over the Wood Chips or Mulch.

B. The Owner's Representative shall approve the appropriate level of protection.

C. In the above requirements, light vehicle is defined as a track skid steer with a ground pressure of 4 psi or lighter. A heavy vehicle is any vehicle with a tire or track pressure of greater than 4 psi. Lightweight materials are any packaged materials that can be physically moved by hand into the location. Bulk materials such as soil, or aggregate shall never be stored within the Tree and Plant Protection Area.

3.8 PROTECTION:

A. Protect the Tree and Plant Protection Area at all times from compaction of the soil; damage of any kind to trunks, bark, branches, leaves and roots of all plants; and contamination of the soil, bark or leaves with construction materials, debris, silt, fuels, oils, and any chemicals substance. Notify the Owner’s Representative of any spills, compaction or damage and take corrective action immediately using methods approved by the Owner’s Representative.

3.9 GENERAL REQUIREMENTS AND LIMITATIONS FOR OPERATIONS WITHIN THE TREE AND PLANT PROTECTION AREA:

A. The Contractor shall not engage in any construction activity within the Tree and Plant Protection Area without the approval of the Owner's Representative including: operating, moving or storing equipment; storing supplies or materials; locating temporary facilities including trailers or portable toilets and shall not permit employees to traverse the area to access adjacent areas of the project or use the area for lunch or any other work breaks. Permitted activity, if any, within the Tree and Plant Protection Area maybe indicated on the drawings along with any required remedial activity as listed below.

B. In the event that construction activity is unavoidable within the Tree and Plant Protection Area, notify the Owner’s Representative and submit a detailed written plan of action for approval. The plan shall include: a statement detailing the reason for the activity including

why other areas are not suited; a description of the proposed activity; the time period for the activity, and a list of remedial actions that will reduce the impact on the Tree and Plant Protection Area from the activity. Remedial actions shall include but shall not be limited to the following:

1. In general, demolition and excavation within the drip line of trees and shrubs shall proceed with extreme care either by the use of hand tools, directional boring and or Air Knife excavation where indicated or with other low impact equipment that will not cause damage to the tree, roots or soil.
2. When encountered, exposed roots, 1 inches and larger in diameter shall be worked around in a manner that does not break the outer layer of the root surface (bark). These roots shall be covered in Wood Chips and shall be maintained above permanent wilt point at all times. Roots one inch and larger in diameter shall not be cut with out the approval of the owners representative. Excavation shall be tunneled under these roots without cutting them. In the areas where roots are encountered, work shall be performed and scheduled to close excavations as quickly as possible over exposed roots.
3. Tree branches that interfere with the construction may be tied back or pruned to clear only to the point necessary to complete the work. Other branches shall only be removed when specifically indicated by the Owner's Representative. Tying back or trimming of all branches and the cutting of roots shall be in accordance with accepted arboricultural practices (ANSI A300, part 8) and be performed under supervision of the arborist.
4. Matting: Install temporary matting over the Wood Chips or Mulch to the extent indicated. Do not permit foot traffic, scaffolding or the storage of materials within the Tree and Plant Protection Area to occur off of the temporary matting.
5. Trunk Protection: Protect the trunk of each tree to remain by covering it with a ring of 8 foot long 2 inch x 6 - inch planks loosely banded onto the tree with 3 steel bands. Staple the bands to the planks as necessary to hold them securely in place. Trunk protection must by kept in place no longer than 12 months. If construction requires work near a particular tree to continue longer than 12 months, the steel bands shall be inspected every six months and loosened if they are found to have become tight.
6. Air Excavation Tool: If excavation for footings or utilities is required within the Tree and Plant Protection Area, air excavation tool techniques shall be used where practical or as designed on the drawings.
    a. Remove the Wood Chips from an area approximately 18 inches beyond the limits of the hole or trench to be excavated. Cover the Wood Chips for a distance of not less than 15 feet around the limit of the excavation area with Filter Fabric or plastic sheeting to protect the Wood Chips from silt. Mound the Wood Chips so that the plastic slopes towards the excavation.
    b. Using a sprinkler or soaker hose, apply water slowly to the area of the excavation for a period of at least 4 hours, approximately 12 hours prior to the work so that the ground water level is at or near field capacity at the beginning of the work. For excavations that go beyond the damp soil, rewet the soil as necessary to keep soil moisture near field capacity.
    c. Using an air excavation tool specifically designed and manufactured for the intended purpose, and at pressures recommended by the manufacturer of the equipment, fracture the existing soil to the shape and the depths required. Work at rates and using techniques that do not harm tree roots. Air pressure shall be a maximum of

90-100 psi.

1.) The air excavation tool shall be “Air-Spade” as manufactured by Concept Engineering Group, Inc., Verona, PA (412) 826-8800, or Air Knife as manufactured by Easy Use Air Tools, Inc. Allison Park, Pa (866) 328-5723 or approved equal.

d. Using a commercial, high-powered vacuum truck if required, remove the soil from the excavation produced by the Air Knife excavation. The vacuum truck should generally operate simultaneously with the hose operator, such that the soil produced is picked up from the excavation hole, and the exposed roots can be observed and not damaged by the ongoing operation. Do not drive the vacuum truck into the Tree and Plant Protection Area unless the area is protected from compaction as approved in advance by the Owner’s Representative.
e. Remove all excavated soil and excavated Wood Chips, and contaminated soil at the end of the excavation.
f. Schedule the work so that foundations or utility work is completed immediately after the excavation. Do not let the roots dry out. Mist the roots several times during the day. If the excavated area must remain open over night, mist the roots and cover the excavation with black plastic.
g. Dispose of all soil in a manner that meets local laws and regulations.
h. Restore soil within the trench as soon as the work is completed. Utilize soil of similar texture to the removed soil and lightly compact with hand tools. Leave soil mounded over the trench to a height of approximately 10% of the trench depth to account for settlement.
i. Restore any Geogrids, Filter Fabric, Wood Chips or Mulch and or matting that was previously required for the area.

3.10 TREE REMOVAL:

A. Remove all trees indicated by the drawings and specifications, as requiring removal, in a manner that will not damage adjacent trees or structures or compacts the soil.

B. Remove trees that are adjacent to trees or structures to remain, in sections, to limit the opportunity of damage to adjacent crowns, trunks, ground plane elements and structures.

C. Do not drop trees with a single cut unless the tree will fall in an area not included in the Tree and Plant Protection Area. No tree to be removed within 50 feet of the Tree and Plant Protection Area shall be pushed over or up-rooted using a piece of grading equipment.

D. Protect adjacent paving, soil, trees, shrubs, ground cover plantings and understory plants to remain from damage during all tree removal operations, and from construction operations. Protection shall include the root system, trunk, limbs, and crown from breakage or scarring, and the soil from compaction.

E. Remove stumps and immediate root plate from existing trees to be removed. Grind trunk bases and large buttress roots to a depth of the largest buttress root or at least 18 inches below the top most roots which ever is less and over the area of three times the diameter of the trunk (DBH).

1. For trees where the stump will fall under new paved areas, grind roots to a total depth of 18 inches below the existing grade. If the sides of the stump hole still have greater than approximately 20% wood visible, continue grinding operation deeper and or wider until the resulting hole has less than 20% wood. Remove all wood chips produced by the

grinding operation and back fill in 8 inch layers with controlled fill of a quality acceptable to the site engineer for fill material under structures, compacted to 95% of the maximum dry density standard proctor. The Owner's Representative shall approve each hole at the end of the grinding operation.

2. In areas where the tree location is to be a planting bed or lawn, remove all woodchips and backfill stump holes with planting soil as defined in Specification Section Planting Soil, in maximum of 12 inch layers and compact to 80 - 85% of the maximum dry density standard proctor.

3.11 PRUNING:

A. Within six months of the estimated date of substantial completion, prune all dead or hazardous branches larger than 2 inch in diameter from all trees to remain.

B. Implement all pruning recommendations found in the arborist report.

C. Prune any low, hanging branches and vines from existing trees and shrubs that overhang walks, streets and drives, or parking areas as follows:
   1. Walks - within 8 feet vertically of the proposed walk elevation.
   2. Parking areas - within 12 feet vertically of the proposed parking surface elevation.
   3. Streets and drives - within 14 feet vertically of the proposed driving surface elevation.

D. All pruning shall be done in accordance with ANSI A300 (part 1), ISA BMP Tree Pruning (latest edition, and the "Structural Pruning: A Guide for the Green Industry", Edward Gilman, Brian Kempf, Nelda Matheny and Jim Clark, 2013 Urban Tree Foundation, Visalia CA.

E. Perform other pruning task as indicated on the drawings or requested by the Owner's Representative.

F. Where tree specific disease vectors require, sterilize all pruning tools between the work in individual trees.

3.12 WATERING

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants to be preserved during the entire construction period. Adequate water is defined to be maintaining soil moisture above the permanent wilt point to a depth of 8 inches or greater.

B. The Contractor shall adjust the automatic irrigation system, if available, and apply additional water, using hoses or water tanks as required.

C. Periodically test the moisture content in the soil within the root zone to determine the water content.

3.13 WEED REMOVAL

A. During the construction period, control any plants that seed in and around the fenced Tree and Plant Protection area at least three times a year.
   1. All plants that are not shown on the planting plan or on the Tree and Plant Protection Plan to remain shall be considered as weeds.

B. At the end of the construction period provide one final weeding of the Tree and Plant Protection Area.

3.14 INSECT AND DISEASE CONTROL

A. Monitor all plants to remain for disease and insect infestations during the entire construction period. Provide all disease and insect control required to keep the plants in a healthy state using the principles of Integrated Plant Management (IPM). All pesticides shall be applied by a certified pesticide applicator.

3.15 CLEAN-UP

A. During tree and plant protection work, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
   1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.

B. Once tree protection work is complete, wash all soil from pavements and other structures. Ensure that Mulch is confined to planting beds.

C. Make all repairs to grades, ruts, and damage to the work or other work at the site.

D. Remove and dispose of all excess Mulch, Wood Chips, packaging, and other material brought to the site by the Contractor.

3.16 REMOVAL OF FENCING AND OTHER TREE AND PLANT PROTECTION

A. At the end of the construction period or when requested by the Owner's Representative remove all fencing, Wood Chips or Mulch, Geogrids and Filter Fabric, trunk protection and or any other Tree and Plant Protection material.

3.17 DAMAGE OR LOSS TO EXISTING PLANTS TO REMAIN

A. Any trees or plants designated to remain, and which are damaged by the Contractor shall be replaced in kind by the Contractor at their own expense. Trees shall be replaced with a tree of similar species and of equal size or 6 inch caliper which ever is less. Shrubs shall be replaced with a plant of similar species and equal size or the largest size plants reasonably available which ever is less. Where replacement plants are to be less than the size of the plant that is damaged, the Owner's Representative shall approve the size and quality of the replacement plant.
   1. All trees and plants shall be installed per the requirements of Specification Section Planting.

B. Plants that are damaged shall be considered as requiring replacement or appraisal in the event that the damage affects more than 25 % of the crown, 25% of the trunk circumference, or root protection area, or the tree is damaged in such a manner that the tree could develop into a potential hazard. Trees and shrubs to be replaced shall be removed by the Contractor at his own expense.
   1. The Owner's Representative may engage an independent arborist to assess any tree or plant that appears to have been damaged to determine their health or condition.

C. Any tree that is determined to be dead, damaged or potentially hazardous by the Owner's arborist and upon the request of the Owner's Representative shall be immediately removed by the Contractor at no additional expense to the owner. Tree removal shall include all clean

up of all wood parts and grinding of the stump to a depth sufficient to plant the replacement tree or plant, removal of all chips from the stump site and filling the resulting hole with topsoil.

D. Any remedial work on damaged existing plants recommended by the consulting arborist shall be completed by the Contractor at no cost to the owner. Remedial work shall include but is not limited to: soil compaction remediation and vertical mulching, pruning and or cabling, insect and disease control including injections, compensatory watering, additional mulching, and could include application tree growth regulators (TGR).

E. Remedial work may extend up to two years following the completion of construction to allow for any requirements of multiple applications or the need to undertake applications at required seasons of the year.

END OF SECTION

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling and comparable products.

1.02 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
   3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
   1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
   1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
   2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 01 33 00 "Submittal Procedures."

F. Substitution: Refer to Section 01 25 00 "Substitution Procedures" for definition and limitations on substitutions.

1.03 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

1.05 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.

B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
   a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
   a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
   a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
   a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
   a. For approval of products by unnamed manufacturers, comply with requirements in Section 01 25 00 "Substitution Procedures" for substitutions for convenience.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
   1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.
   1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.02 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
   1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
   2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
   3. Evidence that proposed product provides specified warranty.
   4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
   5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation, as specified in Section 01 33 00 "Submittal Procedures."
   1. Form of Approval of Submittal: As specified in Section 01 33 00 "Submittal Procedures."

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

D. Submittal Requirements, Single-Step Process: When acceptable to Architect, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by the Architect of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
   1. Installation of the Work.
   2. Progress cleaning.
   3. Starting and adjusting.
   4. Protection of installed construction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.
   1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
   2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
   2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.03 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architectpromptly.

B. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

3.04 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb, and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
   4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.

3.05 PROGRESS CLEANING

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
   a. Use containers intended for holding waste materials of type to be stored.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.06 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.07 PROTECTION AND REPAIR OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
   1. Cutting and patching.

1.02 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.03 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.
   1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Architect of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
      a. Contractor's superintendent.
      b. Trade supervisor responsible for cutting operations.
      c. Trade supervisor(s) responsible for patching of each type of substrate.
      d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
      e. HVAC shutdown and sealing of air intakes.
   2. Coordinate work activities with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
   3. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.04 INFORMATIONAL SUBMITTALS

A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
   1. Extent: Describe reason for and extent of each occurrence of cutting and patching.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
    a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.05 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Comply with requirements specified in other Sections.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

PART 3 - EXECUTION

3.01 CUTTING AND PATCHING

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of Work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 01 10 00 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Roofing Membrane Assemblies: Patch roofing membrane penetrations and transitions with reinforced, liquid applied PMMA flashing membrane. Embed roofing granules to match existing roofing granule cap and flashing sheets.
6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
   1. Substantial Completion procedures.
   2. Final completion procedures.
   3. Warranties.
   4. Final cleaning.

1.02 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.03 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.04 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
   1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
   3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
5. Submit testing, adjusting, and balancing records.
6. Submit sustainable design submittals not previously submitted.
7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1.05 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Division 01 Section payment procedures."

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1.06 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize list of spaces in sequential order, starting with exterior areas first andproceeding from lowest floor to highest floor, listed by room or space number.
2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Contractor.
    e. Page number.
4. Submit list of incomplete items in the following format:
    a. PDF Electronic File: Architect will return annotated file.

1.07 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

A. Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
   1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
      a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
      b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
      c. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
      d. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
      e. Vacuum and mop concrete.
      f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
      g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
      h. Remove labels that are not permanent.
      i. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

j. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
k. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
l. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
m. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
n. Clean strainers.
o. Leave Project clean and ready for occupancy.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Systems and equipment operation manuals.
   2. Systems and equipment maintenance manuals.
   3. Product maintenance manuals.

1.02 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:
   1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.

C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training.

1.03 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
   1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
   2. Performance and design criteria if Contractor has delegated design responsibility.
   3. Operating standards.
   4. Operating procedures.
   5. Operating logs.
   6. Wiring diagrams.
   7. Control diagrams.
   8. Piped system diagrams.
   9. Precautions against improper use.
   10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:
   1. Product name and model number. Use designations for products indicated on Contract Documents.
   2. Manufacturer's name.
   3. Equipment identification with serial number of each component.
   4. Equipment function.
   5. Operating characteristics.
   6. Limiting conditions.
   7. Performance curves.
   8. Engineering data and tests.
   9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:
   1. Startup procedures.
   2. Equipment or system break-in procedures.
   3. Routine and normal operating instructions.
   4. Regulation and control procedures.
   5. Instructions on stopping.
   6. Normal shutdown instructions.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.05 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of maintenance manuals.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.06 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:
1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 78 36 - WARRANTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for warranties on products and systems.

B. Related Sections:
   1. Section 01 77 00 "Closeout Procedures" for submitting warranties.

1.02 WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product, system, and installation warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product or system and issued in the name of the Owner or endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner for a particular product or system and issued in the name of the Owner or endorsed by manufacturer to Owner.
      a. Installation Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner for a particular product or system and issued in the name of the Owner or endorsed by installer to Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
   3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
   1. Record Drawings.
   2. Record specifications.

1.02 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set of marked-up record prints.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

1.03 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
   1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an acceptable drawing technique.
      c. Record data as soon as possible after obtaining it.
      d. Record and check the markup before enclosing concealed installations.
      e. Cross-reference record prints to corresponding photographic documentation.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
      c. Depths of foundations.
      d. Locations and depths of underground utilities.
      e. Revisions to routing of piping and conduits.
      f. Revisions to electrical circuitry.
      g. Actual equipment locations.
      h. Duct size and routing.
      i. Locations of concealed internal utilities.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

j. Changes made by Change Order or Construction Change Directive.
k. Changes made following Architect's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file.
3. Identification: As follows:
a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Architect.
e. Name of Contractor.

1.04 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Note related Change Orders and Record Drawings where applicable.

B. Format: Submit record specifications as annotated PDF electronic file .

1.05 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 81 13.71 - SUSTAINABLE DESIGN REQUIREMENTS - CALGREEN NON-RESIDENTIAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General requirements and procedures for compliance with 24 CCR 11, California Green Building Standards Code (CALGreen).
   1. Some CALGreen requirements depend on product selections and may not be specifically identified as CALGreen requirements. Compliance with CALGreen requirements may be used as one criterion to evaluate substitution requests and comparable product requests.
   2. Some CALGreen requirements depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
   3. Additional CALGreen requirements not included in this specification apply to the Project.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 DEFINITIONS

A. CALGreen: California Green Building Standards Code, including supplements in effect as of date of the Contract Documents unless otherwise indicated.
   1. Definitions that are part of CALGreen apply to this Section.

1.03 CONFLICTING REQUIREMENTS

A. Conflicting Sustainable Design Requirements: In the event of a conflict between Sustainable Design Requirements specification sections, comply with the more stringent requirement.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect about CALGreen requirements that depend on product selection or product qualities. Document responses as informational submittals.

B. When requested by enforcing agency submit substantiating documentation confirming compliance with CALGreen requirements.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Sustainable design submittals shall be identified and submitted separately from other submittals.

1.05 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Documentation for Construction and Demolition Waste Management: Submit documentation complying with CALGreen for one of the following:
a. Construction Waste Management Plan.
b. Waste Management Company.
c. Waste Stream Reduction Alternative.
2. IAQ testing report from testing and inspecting agency indicating results of IAQ testing and documentation that show compliance with IAQ testing procedures and requirements.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Construction and Demolition Waste Management: Achieve end-of-Project rates for salvage/recycling of not less than 65 percent of total nonhazardous solid waste generated by the Work. Comply with local construction and demolition waste management ordinance when it is more stringent.

B. Universal Waste: Universal Waste items such as fluorescent lamps and ballast, and mercury containing thermostats, as well as other California prohibited Universal Waste materials shall be disposed of properly and diverted from landfills.

C. Site-Clearing Waste: 100 percent of trees, stumps, rocks and associated vegetation and soils resulting primarily from land clearing shall be reused or recycled. If contamination by disease or pest infestation is suspected, contact the Country Agricultural Commissioner and follow its direction for recycling or disposal of the material.

2.02 MATERIALS

A. Provide products and procedures necessary to comply with CALGreen requirements in this Section. Although other Sections may specify some requirements that contribute to referenced CALGreen requirements, determine additional materials and procedures necessary to comply with CALGreen requirements indicated.

2.03 LOW-EMITTING MATERIALS

A. Adhesives and Sealants:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. For field applications, adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers, and caulks shall comply with VOC content limits of authorities having jurisdiction, or the following VOC content limits:
   a. Indoor Carpet Adhesives: 50 g/L.
   b. Carpet Pad Adhesives: 50 g/L.
   c. Outdoor Carpet Adhesives: 150 g/L.
   d. Wood Flooring Adhesive: 100 g/L.
   e. Rubber Floor Adhesives: 60 g/L.
   f. Subfloor Adhesives: 50 g/L.
   g. Ceramic Tile Adhesives: 65 g/L.
   h. VCT and Asphalt Tile Adhesives: 50 g/L.
   i. Gypsum Board and Panel Adhesives: 50 g/L.
   j. Cove Base Adhesives: 50 g/L.
   k. Multipurpose Construction Adhesives: 70 g/L.
   l. Structural Glazing Adhesives: 100 g/L.
   m. Single-Ply Roof Membrane Adhesive: 250 g/L.
   n. Other Adhesive Not Specifically Listed: 50 g/L
   o. PVC Welding Compounds: 510 g/L.
   p. CPVC Welding Compounds: 490 g/L.
   q. ABS Welding Compounds: 325 g/L.
   r. Plastic Cement Welding Compounds: 250 g/L.
   s. Adhesive Primer for Plastic: 550 g/L.
   t. Contact Adhesive: 80 g/L.
   u. Special-Purpose Contact Adhesive (Contact Adhesive That Is Used to Bond Melamine Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
   v. Structural Wood Member Adhesives: 140 g/L.
   w. Top and Trim Adhesive: 250 g/L.
   x. Metal-to-Metal Adhesives: 30 g/L.
   y. Plastic Foam Adhesives: 50 g/L.
   z. Adhesives for Porous Materials (except Wood): 50 g/L.
   aa. Wood Glues: 30 g/L.
   bb. Fiberglass Adhesives: 80 g/L.
   cc. Architectural Sealants: 250 g/L.
   dd. Nonmembrane Roof Sealants: 300 g/L.
   ee. Roadway Sealants: 250 g/L.
   ff. Single-Ply Roof Membrane Sealants: 450 g/L.
   gg. Other Sealants: 420 g/L.
   hh. Sealant Primers for Nonporous Substrates: 250 g/L.
   ii. Sealant Primers for Porous Substrates: 775 g/L.
   jj. Modified Bituminous Sealant Primers: 500 g/L.
   kk. Other Sealant Primers: 750 g/L.
2. Prohibited Ingredients: Adhesives and sealants must not contain the following:
   a. Chloroform.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Ethylene dichloride.
c. Methylene chloride.
d. Perchloroethylene.
e. Trichloroehtylene.

3. Additional Requirements: Comply with additional requirements in CALGreen for aerosol adhesives, and small unit sizes of adhesives, and sealant or caulking compounds.

B. Paints and Coatings:

1. For field applications, paints and coatings shall comply with VOC limits of California Air Resources Board (CARB) Architectural Coatings Suggested Control Measure (SCM) below, unless more stringent local limits apply. The VOC content limit for coatings that do not meet the definitions for the specialty coatings categories listed shall be determined by classifying the coating as flat, nonflat, or nonflat-high gloss coating, based on its gloss.
   a. Flat Coatings: 50 g/L.
   b. Nonflat Coatings: 100 g/L.
   c. Nonflat - High Gloss Coatings: 150 g/L.
   d. Specialty Coatings:
      1) Aluminum Roof Coatings: 400 g/L.
      2) Basement Special Coatings: 400 g/L.
      3) Bituminous Roof Coatings: 50 g/L.
      4) Bituminous Roof Primers: 350 g/L.
      5) Bond Breakers: 350 g/L.
      6) Concrete Curing Compounds: 350 g/L.
      7) Concrete/Masonry Sealers: 100 g/L.
      8) Driveway Sealers: 50 g/L.
      9) Dry-Fog Coatings: 150 g/L.
      10) Faux Finishing Coatings: 350 g/L.
      11) Fire-Resistive Coatings: 350 g/L.
      12) Floor Coatings: 100 g/L.
      13) Form-Release Compounds: 250 g/L.
      14) Graphic Arts Coatings (Sign Paints): 500 g/L.
      15) High-Temperature Coatings: 420 g/L.
      16) Industrial Maintenance Coatings: 250 g/L.
      17) Low Solids Coatings: 120 g/L.
      18) Magnesite Cement Coatings: 450 g/L.
      19) Mastic Texture Coatings: 100 g/L.
      20) Metallic Pigmented Coatings: 500 g/L.
      21) Multi-Color Coatings: 250 g/L.
      22) Pretreatment Wash Primers: 420 g/L.
      23) Primers, Sealers, and Undercoaters: 100 g/L.
      24) Reactive Penetrating Sealers: 350 g/L.
      25) Recycled Coatings: 250 g/L.
      26) Roof Coatings: 50 g/L.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

27) Rust-Preventive Coatings: 250 g/L.
28) Shellacs, Clear: 730 g/L.
29) Shellacs, Opaque: 550 g/L.
30) Specialty Primers, Sealers and Undercoaters: 100 g/L.
31) Stains: 250 g/L.
32) Stone Consolidants: 450 g/L.
33) Swimming Pool Coatings: 340 g/L.
34) Traffic Marking Coatings: 100 g/L.
35) Tub and Tile Refinish Coatings: 420 g/L.
36) Waterproof Membranes: 250 g/L.
37) Wood Coatings: 275 g/L.
38) Wood Preservatives: 350 g/L.
39) Zinc-Rich Primers: 340 g/L.

2. Additional Requirements: Comply with additional requirements in CALGreen for aerosol paints and coatings.

C. Carpet Systems: All interior carpet materials, including cushion, shall comply with at least one of the following:
1. Carpet and Rug Institute's Green Label Plus program.
2. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

D. Composite Wood Products: Composite wood products used on the interior or exterior of the building shall have formaldehyde emission rates not greater than the following specified by the California Air Resources Board (CARB), Air Toxics Control Measure (ATCM) for Composite Wood, as tested in accordance with ASTM E1333:
1. Hardwood Plywood (Veneer Core and Composite Core): 0.05 ppm.
2. Particleboard: 0.09 ppm.
3. Medium-Density Fiberboard More Than 5/16 Inch Thick: 0.11 ppm.
4. Medium-Density Fiberboard 5/16 Inch or Less in Thickness: 0.13 ppm.

E. Composite Wood Products, Tier 1: Composite wood products shall be approved by the California Air Resources Board (CARB), as no-added formaldehyde (NAF) based resins or ultra-low emitting formaldehyde (ULEF) resins.

F. Resilient Flooring Systems: Where resilient flooring is installed, at least 80 percent of floor area receiving resilient flooring shall meet the requirements comply with the following:
1. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Thermal Insulation: Thermal insulation products shall comply with VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

H. Acoustical Ceilings and Wall Panels: Acoustical ceilings and wall panels shall comply with VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

PART 3 - EXECUTION

3.01 CONSTRUCTION WASTE MANAGEMENT

A. Construction and Demolition Waste Management: Achieve specified rates for waste management by one of the following:
   1. Construction Waste Management Plan: Where a local jurisdiction does not have a construction and demolition waste management ordinance that is more stringent, submit a construction waste management plan that includes the following:
      a. Identification of construction and demolition waste materials to be diverted from disposal by efficient usage, recycling, reuse on the Project or salvage for future use or sale.
      b. Determination of construction and demolition waste materials will be sorted on-site (source separated) or bulk mixed (single stream).
      c. Identification of diversion facilities where construction and demolition waste material collected will be taken.
      d. Specification of the amount of construction and demolition waste materials diverted shall be taken by weight or volume, but not by both.
   2. Waste Management Company: Utilize a waste management company that can provide verifiable documentation that the percentage of construction and demolition waste material diverted from the landfill complies with CALGreen.
   3. Waste Stream Reduction Alternative: The combined weight of new construction disposal that does not exceed two pounds per square foot of building area shall be deemed to meet the 65 percent minimum requirement as approved by the enforcing agency.

3.02 CONSTRUCTION IAQ MANAGEMENT

A. Cover or close openings in ducts and other related air-distribution component openings with tape, plastic, sheet metal, or other approved method before beginning dust-producing operations and maintain until dust-producing operations are complete.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period, install MERV 8 filter media according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
   1. Replace all air filters immediately prior to occupancy.

3.03 INDOOR-AIR-QUALITY ASSESSMENT

A. Air-Quality Testing:
   1. Conduct baseline IAQ testing, after substantial completion of construction and prior to occupancy, in accordance with the EPA's "Testing for Indoor Air Quality - Section 01 81 09 "
   2. Verify compliance with standards and limits in the EPA's "Testing for Indoor Air Quality - Section 01 81 09 "
      a. Carbon monoxide maximum is 9 ppm, not to exceed outdoor levels by 2 ppm.
      b. Formaldehyde maximum is 27 ppb.
      c. Particulates maximum is 50 micrograms per cubic meter.
      d. 4-Phenylcyclohexene maximum is 6.5 micrograms per cubic meter.
      e. Total VOC maximum is 300 micrograms per cubic meter.
   3. For each sampling point where the maximum concentration limits are exceeded, take corrective action until air samples indicate compliance.
   4. If noncompliant test results occur, provide a written report describing source(s) of noncompliant condition(s) and corrective action(s) implemented.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 01 81 13.81 - SUSTAINABLE DESIGN REQUIREMENTS - CHPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General requirements and procedures for compliance with CHPS.
   1. Some CHPS requirements depend on product selections and may not be specifically identified as CHPS requirements. Compliance with CHPS requirements may be used as one criterion to evaluate substitution requests and comparable product requests.
   2. Some CHPS requirements depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
   3. Additional CHPS requirements not included in this specification apply to the Project.
   4. A copy of the CHPS scorecard is attached at the end of this Section for information only.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 01 91 13 "General Commissioning Requirements" for commissioning requirements relating to CHPS requirements.

1.02 DEFINITIONS

A. CHPS: California Collaborative for High Performance Schools v2.0 Criteria, including supplements in effect as of date of the Contract Documents unless otherwise indicated.
   1. Definitions that are part of CHPS apply to this Section.

1.03 CONFLICTING REQUIREMENTS

A. Conflicting Sustainable Design Requirements: In the event of a conflict between Sustainable Design Requirements specification sections, comply with the more stringent requirement.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect about CHPS requirements that depend on product selection or product qualities. Document responses as informational submittals.

B. When requested by enforcing agency submit substantiating documentation confirming compliance with CHPS requirements.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Sustainable design submittals shall be identified and submitted separately from other submittals.

D. Submit data and calculations of costs, quantities, volume, or area information where it is necessary to determine compliance with requirements.

1.05 INFORMATIONAL SUBMITTALS

A. Sustainable Design Action Plans: Provide preliminary submittals within 14 days of date established for the Notice of Award, indicating how the following requirements will be met:
   1. Environmental Product Declarations: List of proposed products with Environmental Product Declarations.
   2. Material Health Disclosures: List of proposed products with Material Health Disclosures.
   3. Construction IAQ management plan.

B. Sustainable Design Submittals:
   1. Documentation for Construction Indoor Air Quality (IAQ) Management: Submit the following:
      a. SMACNA Guideline Documentation: Minimum of six photographs at three different times during construction period, along with a brief description of SMACNA approach employed, documenting implementation of IAQ management measures, including protection of ducts and on-site stored or installed absorptive materials.
      b. Building Flush-Out Documentation: Signed narrative statement and photographs describing the building air flush-out procedures, including dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
      c. Mold and Moisture Management Documentation: Minimum of six photographs at three different times during construction period, along with a brief description of implemented measures for protection of building materials from mold and moisture damage.
   2. Material health disclosures complying with CHPS requirements.
   3. Documentation for Construction Waste Management: Submit documentation complying with CHPS for one of the following:
      a. Construction Waste Management Plan.
      b. Waste Management Company.
      c. Waste Stream Reduction Alternative.
   4. Environmental Product Declarations complying with CHPS requirements.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.06 CONSTRUCTION INDOOR-AIR-QUALITY (IAQ) MANAGEMENT PLAN

A. Construction IAQ Management Plan: Provide a plan indicating IAQ management measures in accordance with SMACNA control measures for maintaining good indoor air quality on the Project site. For occupied renovations, follow SMACNA's "SMACNA IAQ Guideline for Occupied Buildings Under Construction". List each measure to be implemented and describe implementation procedures. List measures applicable to project including, but not limited to, the following:

1. HVAC Protection:
    a. Use of temporary ventilation units.
    b. Protection of all HVAC equipment from dust and odors and sealing of duct and equipment openings with plastic.
    c. Protection of return side of system when system serves occupied spaces or protects finished work.
    d. Installation and maintenance of temporary filters over grilles and openings if returns cannot be closed.
    e. Isolation of unducted plenums over constructions zones, if used.
    f. Avoidance of use of mechanical rooms for construction storage.
    g. Replacement of all filtration media before occupancy.
2. Source Control:
    a. Identification of control measures for materials containing VOCs.
    b. Recovery, isolation, and ventilation of containers containing toxic materials.
    c. Exhausting of fumes from idling vehicles and gasoline-fueled tools to the building exterior.
3. Pathway Interruption:
    a. Isolation of construction activity from completed or occupied spaces.
    b. Ventilation using 100 percent outside air, when allowed by weather.
    c. Depressurization of construction areas.
    d. Use of temporary barrier to contain construction area.
4. Progress Cleaning:
    a. Implementation of cleaning activities to control contaminants in building spaces during construction and before occupancy.
    b. Protection of all porous building materials from exposure to moisture and storage in clean areas.
    c. Use of vacuum cleaners with high-efficiency particulate filters.
    d. Increased cleaning frequency and use of wetting agents for dust.
5. Scheduling:
    a. Coordination of construction activities to minimize disruption to occupied areas.
    b. Sequencing of construction activities to minimize impact on indoor air quality.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Construction Waste Management: Achieve end-of-Project rates for salvage/recycling of not less than 65 percent of total nonhazardous solid waste generated by the Work. Comply with local construction and demolition waste management ordinance when it is more stringent.

B. Construction Waste Management: Achieve end-of-Project rates for salvage/recycling of not less than 50 percent of total nonhazardous construction and demolition waste, not including land clearing and associated debris.

2.02 MATERIALS

A. Provide products and procedures necessary to comply with CHPS requirements in this Section. Although other Sections may specify some requirements or identify sustainable design criteria associated with products and materials that contribute to referenced CHPS requirements, Contractor shall determine additional materials and procedures necessary, verify specified criteria for those products and materials used, and provide additional information necessary to comply with CHPS requirements indicated.

B. Material Health Disclosures: Provide at least 20 different products from at least five different manufacturers using CHPS-approved programs demonstrating material health and inventory to at least 1000 ppm.

C. Environmental Product Declaration: Provide at least 10 different products that have a third-party certified Environmental Product Declaration conforming to CHPS requirements.

2.03 LOW-EMITTING MATERIALS

A. Paints and Coatings:
   1. For field applications within the weatherproofing system, paints and coatings shall comply with VOC limits of California Air Resources Board (CARB) Architectural Coatings Suggested Control Measure (SCM) below, unless more stringent local limits apply. The VOC content limit for coatings that do not meet the definitions for the specialty coatings categories listed shall be determined by classifying the coating as flat, nonflat, or nonflat-high gloss coating, based on its gloss.
      a. Flat Coatings: 50 g/L.
      b. Nonflat Coatings: 100 g/L.
      c. Nonflat - High Gloss Coatings: 150 g/L.
      d. Specialty Coatings:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1) Aluminum Roof Coatings: 400 g/L.
2) Basement Special Coatings: 400 g/L.
3) Bituminous Roof Coatings: 50 g/L.
4) Bituminous Roof Primers: 350 g/L.
5) Bond Breakers: 350 g/L.
6) Concrete Curing Compounds: 350 g/L.
7) Concrete/Masonry Sealers: 100 g/L.
8) Driveway Sealers: 50 g/L.
9) Dry-Fog Coatings: 150 g/L.
10) Faux Finishing Coatings: 350 g/L.
11) Fire-Resistive Coatings: 350 g/L.
12) Floor Coatings: 100 g/L.
13) Form-Release Compounds: 250 g/L.
14) Graphic Arts Coatings (Sign Paints): 500 g/L.
15) High-Temperature Coatings: 420 g/L.
16) Industrial Maintenance Coatings: 250 g/L.
17) Low Solids Coatings: 120 g/L.
18) Magnesite Cement Coatings: 450 g/L.
19) Mastic Texture Coatings: 100 g/L.
20) Metallic Pigmented Coatings: 500 g/L.
21) Multi-Color Coatings: 250 g/L.
22) Pretreatment Wash Primers: 420 g/L.
23) Primers, Sealers, and Undercoaters: 100 g/L.
24) Reactive Penetrating Sealers: 350 g/L.
25) Recycled Coatings: 250 g/L.
26) Roof Coatings: 50 g/L.
27) Rust-Preventive Coatings: 250 g/L.
28) Shellacs, Clear: 730 g/L.
29) Shellacs, Opaque: 550 g/L.
30) Specialty Primers, Sealers and Undercoaters: 100 g/L.
31) Stains: 250 g/L.
32) Stone Consolidants: 450 g/L.
33) Swimming Pool Coatings: 340 g/L.
34) Traffic Marking Coatings: 100 g/L.
35) Tub and Tile Refinish Coatings: 420 g/L.
36) Waterproof Membranes: 250 g/L.
37) Wood Coatings: 275 g/L.
38) Wood Preservatives: 350 g/L.
39) Zinc-Rich Primers: 340 g/L.

2. Additional Requirements: Comply with additional requirements in CALGreen for aerosol paints and coatings.

B. Flooring Systems:
1. Carpet Systems: All interior carpet materials, including cushion, shall comply with at least one of the following:
a. Carpet and Rug Institute's Green Label Plus program.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

2. Resilient Flooring Systems: Where resilient flooring is installed, at least 80 percent of floor area receiving resilient flooring shall meet the requirements comply with the following:
   a. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2).

C. Composite Wood Products: Composite wood products used on the interior or exterior of the building shall have formaldehyde emission rates not greater than the following specified by the California Air Resources Board (CARB), Air Toxics Control Measure (ATCM) for Composite Wood, as tested in accordance with ASTM E1333:
   1. Hardwood Plywood (Veneer Core and Composite Core): 0.05 ppm.
   2. Particleboard: 0.09 ppm.
   3. Medium-Density Fiberboard More Than 5/16 Inch Thick: 0.11 ppm.
   4. Medium-Density Fiberboard 5/16 Inch or Less in Thickness: 0.13 ppm.

D. Adhesives and Sealants:
   1. For field applications within the weatherproofing system, adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers, and caulks shall comply with VOC content limits of authorities having jurisdiction, or the following VOC content limits:
      a. Indoor Carpet Adhesives: 50 g/L.
      b. Carpet Pad Adhesives: 50 g/L.
      c. Outdoor Carpet Adhesives: 150 g/L.
      d. Wood Flooring Adhesive: 100 g/L.
      e. Rubber Floor Adhesives: 60 g/L.
      f. Subfloor Adhesives: 50 g/L.
      g. Ceramic Tile Adhesives: 65 g/L.
      h. VCT and Asphalt Tile Adhesives: 50 g/L.
      i. Gypsum Board and Panel Adhesives: 50 g/L.
      j. Cove Base Adhesives: 50 g/L.
      k. Multipurpose Construction Adhesives: 70 g/L.
      l. Structural Glazing Adhesives: 100 g/L.
      m. Single-Ply Roof Membrane Adhesive: 250 g/L.
      n. Other Adhesive Not Specifically Listed: 50 g/L
      o. PVC Welding Compounds: 510 g/L.
      p. CPVC Welding Compounds: 490 g/L.
      q. ABS Welding Compounds: 325 g/L.
      r. Plastic Cement Welding Compounds: 250 g/L.
      s. Adhesive Primer for Plastic: 550 g/L.
      t. Contact Adhesive: 80 g/L.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

u. Special-Purpose Contact Adhesive (Contact Adhesive That Is Used to Bond Melamine Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
v. Structural Wood Member Adhesives: 140 g/L.
w. Top and Trim Adhesive: 250 g/L.
x. Metal-to-Metal Adhesives: 30 g/L.
y. Plastic Foam Adhesives: 50 g/L.
z. Adhesives for Porous Materials (except Wood): 50 g/L.
aa. Wood Glues: 30 g/L.
bb. Fiberglass Adhesives: 80 g/L.
cc. Architectural Sealants: 250 g/L.
dd. Nonmembrane Roof Sealants: 300 g/L.
ee. Roadway Sealants: 250 g/L.
ff. Single-Ply Roof Membrane Sealants: 450 g/L.
gg. Other Sealants: 420 g/L.
hh. Sealant Primers for Nonporous Substrates: 250 g/L.
ii. Sealant Primers for Porous Substrates: 775 g/L.
jj. Modified Bituminous Sealant Primers: 500 g/L.
kk. Other Sealant Primers: 750 g/L.

2. Prohibited Ingredients: Adhesives and sealants must not contain the following:
   a. Chloroform.
   b. Ethylene dichloride.
   c. Methylene chloride.
   d. Perchloroethylene.
   e. Trichloroehtylene.
3. Additional Requirements: Comply with additional requirements in CALGreen for aerosol adhesives, and small unit sizes of adhesives, and sealant or caulking compounds.

E. Adhesives and Sealants: For field applications that are inside the weatherproofing system, 90 percent or more by volume of adhesives and sealants shall comply with the following:
1. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2) using the school classroom scenario.

F. Flooring Systems: Where resilient flooring is installed, 100 percent of floor area receiving resilient flooring shall meet the requirements comply with the following:
1. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2) using the school classroom scenario.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Composite Wood and Agrifiber Products: At least 90 percent by area of the composite wood products products used on the interior of the building shall be approved by the California Air Resources Board (CARB), as no-added formaldehyde (NAF) based resins or ultra-low emitting formaldehyde (ULEF) resins. Additionally, at least 90 percent by area of all agrifiber products installed on the building interior shall be manufactured with NAF based resins.
   1. Structural plywood, structural panels, oriented strand board, structural lumber, glue laminated timber, prefabricated wood joists and finger jointed lumber are excluded from these requirements.

H. Paints and Coatings: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings by volume shall comply with the following:
   1. VOC-emission limits and testing requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.2 (CDPH Standard Method v1.2) using the school classroom scenario.

PART 3 - EXECUTION

3.01 CONSTRUCTION WASTE MANAGEMENT

A. Construction Waste Management: Achieve specified rates for waste management by one of the following:
   1. Construction Waste Management Plan: Where a local jurisdiction does not have a construction and demolition waste management ordinance that is more stringent, submit a construction waste management plan that includes the following:
      a. Identification of construction and demolition waste materials to be diverted from disposal by efficient usage, recycling, reuse on the Project or salvage for future use or sale.
      b. Determination of construction and demolition waste materials will be sorted on-site (source separated) or bulk mixed (single stream).
      c. Identification of diversion facilities where construction and demolition waste material collected will be taken.
      d. Specification of the amount of construction and demolition waste materials diverted shall be taken by weight.
   2. Waste Management Company: Utilize a waste management company that can provide verifiable documentation that the percentage of construction and demolition waste material diverted from the landfill complies with CALGreen.
   3. Waste Stream Reduction Alternative: The combined weight of new construction disposal that does not exceed two pounds per square foot of building area shall be deemed to meet the 65 percent minimum requirement as approved by the enforcing agency.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.02 CONSTRUCTION IAQ MANAGEMENT

A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

B. Cover or close openings in ducts and other related air-distribution component openings with tape, plastic, sheet metal, or other approved method before beginning dust-producing operations and maintain until dust-producing operations are complete.
   1. New Duct Systems: Follow SMACNA's "Duct Cleanliness for New Construction Guidelines" according to Advanced Levels of cleanliness including the following:
      a. Ductwork shall be sealed when transported to the Project site.
      b. Store ductwork in clean, dry conditions and keep sealed during storage.
      c. Wipe down internal surfaces of ductwork immediately prior to installation to remove dust.
      d. Seal open ends on completed ductwork and overnight work-in-progress.
      e. During installation, protect ductwork waiting to be installed with surface wrapping.
      f. During construction, seal HVAC supply and return openings to protect them from construction dust infiltration.

C. Flush-Out:
   1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying the designed outdoor air flow rate for maximum occupancy continuously for 24 hours for a period of not less than seven days while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.
      a. If conditions do not allow for temperature or humidity to be maintained within specified limits, adjust fan speed or outdoor air delivery as needed, but extend flush-out period beyond seven days to accomplish the same amount of total air throughput that would have occurred without the adjustments.
      b. After flush-out replace air filters with new filters and provide two sets of additional replacement filters prior to occupancy.
   2. Ventilation after Substantial Completion for Touchups: For Work involving products with chemical emissions, provide temporary construction ventilation during application and extend the building flush-out by a minimum of four days after touch-up application. Provide ventilation with 100 percent tempered outdoor air for 24 hours each day.

D. Mold and Moisture Management: Protect building materials, especially gypsum board, wood, porous insulation, paper, and fabric to keep them dry and prevent the growth of mold and bacteria. Comply with the following:
   1. Cover materials to prevent rain damage.
   2. When storing or resting materials on the ground, use spacers to allow air to circulate between the ground and the materials.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Discard materials that are damp or wet for more than 24 hours.
4. Immediately remove materials showing signs of mold and mildew, including any with moisture stains, from the site and dispose of them properly.
5. Replace moldy materials with new, undamaged materials.

3.03 POST-CONSTRUCTION IAQ MANAGEMENT

A. After construction is complete and prior to occupancy, complete the following:
   1. Vacuum carpeted and soft surfaces with a CRI Seal of Approval certified vacuum or HEPA filter vacuum that meets or exceeds the CRI Seal of Approval program.
      a. For phased or occupied renovations, vacuum surfaces daily in occupied areas and in areas adjacent to those affected by construction activities.
   2. Vacuum hard surfaces with a CRI Seal of Approval certified vacuum or HEPA filter vacuum that meets or exceeds the CRI Seal of Approval program with a brush or hard floor attachment, or use microfiber mops, cloths, and sponges that will capture the dust.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 02 41 16 – DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Furnishing labor, materials and equipment necessary for demolition, dismantling, cutting and alterations as indicated, specified, or required for completion of the Work. Includes items such as the following:

1. Protection of existing improvements to remain.
2. Cleaning existing improvements to remain.
3. Disconnecting and capping utilities.
4. Removing debris, waste materials, and equipment.
5. Removal of items for performance of the Work.
6. Salvageable items to be retained by the Owner.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 1100 - Summary of Work.
3. Section 01 5000 - Construction Facilities and Temporary Controls.
4. Section 01 7329 - Cutting and Patching.
5. Section 01 7419 - Construction and Demolition Waste Management.
6. Division 22 –- Plumbing.
7. Division 23 –- HVAC.
8. Division 26 –- Electrical.

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings indicating the extent of items and systems to be removed. Indicate items to be salvaged or items to be protected during demolition. Indicate locations of utility terminations and the extent of abandoned lines to be removed. Include details indicating methods and location of utility terminations.

1.03 QUALITY ASSURANCE

A. Perform the Work of this section by workers skilled in the demolition of buildings and structures. Perform the Work of this section under direct superintendence at all times.

B. Prior to commencement of Work, schedule a walkthrough with the OAR, to confirm Owner property items have been removed from scheduled Work areas. Identify and mark remaining property items and schedule their removal.

C. Coordinate demolition for the correct sequence, limits, and methods. Schedule demolition Work to create least possible inconvenience to the public and facility operations.

D. Related Standard: ANSI/ASSE A10.6.

1.04 PROJECT CONDITIONS

A. Drawings may not indicate in detail all demolition Work to be performed. Examine existing conditions to determine the full extent of required demolition.

B. Repair damage to existing improvements or damage due to excessive demolition.

C. Provide all measures to avoid excessive damage from inadequate or improper means and methods, improper shoring, bracing or support.

D. If conditions are encountered that varies from those indicated, promptly notify the Architect for clarification before proceeding.

PART 2 - PRODUCTS

2.01 HANDLING OF MATERIALS

A. Items scheduled for salvage by the Owner shall be delivered to a location designated by the OAR. Items shall be cleaned, packaged and labeled for storage.

B. Items scheduled for reuse shall be stored on the Project site and protected from damage, theft and other deleterious conditions.

PART 3 - EXECUTION

3.01 GENERAL

A. Protection:

1. Do not commence demolition until safety partitions, barricades, warning signs and other forms of protection are installed. Refer to Section 01 5000 - Construction Facilities and Temporary Controls.

2. Provide safeguards, including warning signs, lights and barricades, for protection of workers, occupants, and the public.

B. If safety of existing construction appears to be endangered, take immediate measures to correct such conditions; cease operations and immediately notify the OAR.

3.02 DEMOLITION

A. Do not throw or drop materials. Furnish ramps or chutes as required by the Work.

B. Remove existing construction only to extent necessary for proper installation of Work and interfacing with existing construction. Cut back finished surfaces to straight, plumb or level lines as required for a smooth transition.

C. Where openings are cut oversize or in improper locations, replace or repair to required condition.

3.03 CUTTING EXISTING CONCRETE

A. Cutting of existing concrete shall be performed by skilled workers familiar with the requirements and space necessary for placing concrete. Perform concrete cutting with concrete cutting wheels and hand chisels. Do not damage concrete intended to remain.

B. Extent of cutting of structural concrete shall be as indicated on Drawings. Cutting of non-structural concrete shall be as indicated on Drawings or as reviewed by the Architect or structural engineer. Replace concrete demolished in excess of amounts indicated.

C. Prior to cutting or coring concrete, determine locations of hidden utilities or other existing improvements and provide necessary measures to protect them from damage.

3.04 REMOVAL OF EXISTING PLUMBING AND ELECTRICAL EQUIPMENT AND SERVICES

A. Remove existing plumbing and electrical equipment fixtures and services not indicated for reuse and not necessary for completion of the Work. Remove abandoned lines and cap unused portions of existing lines.

3.05 REMOVAL OF OTHER MATERIALS

A. Roofing: Remove as required, including accessory components such as insulation and flashings. At penetrations through existing roofing, trim cut edges back to sound roofing with openings restricted to the minimum size necessary to receive Work.

B. Sheet Metal: Remove back to joint, lap, or connection. Secure loose and unfastened ends or edges and provide a watertight condition. Re-seal as required.

C. Modular materials such as acoustical ceiling panels, resilient tile, or ceramic tile: Remove to a natural joint without leaving damaged or defective Work where joining new Work. After flooring removal, clean substrates to remove setting materials and adhesives.

D. Gypsum Board: Remove to a panel joint line on a stud or support line.

E. Plaster: Saw cut plaster on straight lines, leaving a minimum 2-inch width of firmly attached metal lath for installing new lath and plaster.

F. Remove existing improvements not specifically indicated or required but necessary to perform Work. Cut to clean lines, allowing for installation of Work.

3.06 PATCHING

A. Patch or repair materials to remain when damaged by the performance of the Work of this section. Finish material and appearance of patch and/or repair Work shall match existing.

3.07 CLEANING

A. Clean existing materials to remain with appropriate tools and equipment.

B. Protect existing improvements during cleaning operations.

C. Debris shall be dampened by fog water spray prior to transporting by truck.

D. Debris pick-up area shall be kept broom-clean and shall be washed daily with clean water.

E. Remove waste and debris, other than items to be salvaged. Turn over salvaged items to Owner, or store and protect for reuse where required. Continuously clean up and remove items as demolition Work progresses.

F. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 03 15 00 - CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Waterstops.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete (19 by 25 mm).
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
      b. CETCO; Volclay Waterstop-RX.
      c. Concrete Sealants Inc.; Conseal CS-231.
      d. Greenstreak; Swellstop.
      e. Henry Company, Sealants Division; Hydro-Flex.
      f. JP Specialties, Inc.; Earth Shield Type 20.
   2. Locations: For joints in 8-inch or greater concrete with a minimum concrete coverage of 3 inches and subject to a hydrostatic head no greater than 200 feet.

B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic rubber, for adhesive bonding to concrete.
   1. Product: Adeka; KBA-1510FP.
   2. Locations: For joints in 4-inch or greater concrete with a minimum concrete coverage of 1 inch and subject to a hydrostatic head no greater than 25 feet.

PART 3 - EXECUTION

3.01 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   1. Related sections:
      a. 32 12 16 Concrete Paving

B. Latest edition of American Concrete Institute, ACI 318 and Manual of Concrete Practice (inclusive of all Parts).

C. If conflict occurs between the Contract Drawings, the Project Manual, ACI 318, and the Manual of Concrete Practice, the most stringent takes precedence.

1.02 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:
   1. Division 32 Section "Concrete Paving" for concrete pavement and walks.

1.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

B. Shore: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.

C. Strength Test: The average of the strengths of at least two 6 by 12 inch cylinders or at least three 4 by 8 inch cylinders made from the same sample of concrete and tested at 28 days or at test age designated for determination of specified compressive strength of concrete.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.
   2. Include qualified strength test records if design mixture is based on field experience.
   3. Include results of trial mixtures if design mixture is based on trial mixtures.
   4. Include results of modulus of elasticity tests on trial mixtures.
   5. Design mixture to be signed and sealed by a professional Civil or Structural Engineer licensed in the State in which the Project is constructed.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.05 INFORMATION SUBMITTALS

A. Qualification Data: For Installers.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Curing compounds.
   6. Floor and slab treatments.
   7. Bonding agents.
   8. Vapor retarders, including subbase materials.
   9. Semirigid joint filler.
   10. Joint-filler strips.
   11. Repair materials.

D. Material Test Reports: For the following, from a qualified Testing Agency, indicating compliance with requirements:
   1. Aggregates.

E. ICC ES Evaluation Reports: For evidence of Building Code compliance:
   1. Mechanical splices and connectors for reinforcing steel.

F. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

G. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Architect.

H. Minutes of preinstallation conference.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

F. Concrete Testing Service: Engage a qualified independent Testing Agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at Project site.
   1. Review special inspection and Testing Agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PART 2 – PRODUCTS

2.01 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Structurally sufficient to support weight of plastic concrete and other superimposed loads.
   1. Expanded polystyrene (EPS); ASTM C578, Type XI.
   2. Geofoam (where indicated on drawings), Type EPS22, ASTM D6817, ICC-ES #1006.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2.02 STEEL REINFORCMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.

B. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

C. Low-Alloy-Steel Weldable Reinforcing Bars: ASTM A706/A706M, Grade 60, deformed.

D. Plain-Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.03 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Dowel Bar Sleeves: Circular PVC sleeve, sealed one end, dowel bar embedment plus 1 inch in length, and 1/16 inch annular space inside diameter.

C. Deformed Bar Anchors: ASTM A1064/A1064M, deformed steel wire; AWS D1.1/D1.1M, Type C.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

E. Mechanical Splices and Connectors: Comply with ACI 318 and ACI 439.3R, Type Type II.
   1. Furnish splicing and connector system with current ICC ES Evaluation Report.

2.04 CONCRETE MATERIALS

A. Regional Materials: Provide concrete that has been manufactured within 500 miles of Project site from aggregates and/or cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C150/C150M, Type as indciated. Supplement with the following.
      a. Fly Ash: ASTM C618, Class F.

C. Normal-Weight Aggregates: ASTM C33/33M, Class 1N coarse aggregate, well-graded. Provide aggregates from a single source.
   1. Maximum Coarse Aggregate Size: 1-1/2 inches nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Lightweight Aggregate: ASTM C330/C330M, expanded shale, presize before firing, 3/4-inch nominal maximum aggregate size.

E. Water: ASTM C 94/C94M.

2.05 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   2. Retarding Admixture: ASTM C494/C494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

2.06 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E1745, Class A, 15 mil. Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

C. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C33/C33M for fine aggregates.

2.07 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

B. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

2.08 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.09 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

2.10 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D2240.

C. Reglets: Fabricate reglets in concrete to receive flashing from other trades of not less than 0.022-inch thick galvanized-steel sheet. See Division 07 Section “Sheet Metal Flashing and Trim”. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

D. Dovetail Anchor Slots: Provide as shown on Drawings. Hot-dip galvanized-steel sheet, not less than 0.034-inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.11 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.

2.12 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete indicated on drawings, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent Testing Agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures

B. Modulus of Elasticity: Modulus of elasticity tests (ASTM C469/C469M) shall be performed on laboratory trial mixtures for each concrete strength, each concrete mix design and for each aggregate source. Modulus of elasticity to be tested using servo controlled electromechanical United machines or servo controlled hydraulic Satec machines. Maintain rate of loading to 35 ± 4 psi in lieu of that specified in ASTM C469/C469M.
   1. The modulus of elasticity (psi) at 28 days shall be a minimum of 100% of the target modulus of elasticity.
   2. Target modulus of elasticity (psi):
      a. For $f'_c \leq 6{,}000$ psi: $57{,}000\ (f'_c\ f'_c)^{1/2}$
      b. For $f'_c > 6{,}000$ psi: $40{,}000\ (f'_c)^{1/2} + 1 \times 10^6$
      c. f'_c is the specified concrete strength in psi at 28 days.

3. A modulus of elasticity test shall be the average modulus of elasticity from a set of two (minimum) specimens obtained from same sample.
4. Use a qualified independent Testing Agency for preparing and reporting results of modulus of elasticity tests.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent maximum
   a. Fly ash is not permitted in suspended slabs.

D. Water-soluble chloride ion content shall be determined by ASTM C1218/C1218M at age between 28 and 42 days. Submit documentation verifying compliance. Limit water-soluble, chloride-ion content in hardened concrete to:
1. 1.00 percent by weight of cement for mild-reinforced concrete.
2. 0.06 percent by weight of cement for post-tensioned concrete.

E. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.13 FABRICATION REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - PART 3 – EXECUTION

3.01 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117, unless specified otherwise in the Contract Documents.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   1. Class A, 1/8 inch for smooth-formed finished surfaces.
   2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
   1. Install keyways, reglets, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete, unless otherwise indicated on Drawings.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."

3.03 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
   1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength.
   2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Granular Course: Placement as noted on drawings, 4-inch bed of granular fill, material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
   1. Fine-Graded Granular Material: Place and compact a 1/2-inch layer of fine-graded granular material over granular fill.

3.05 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
1. Weld reinforcing bars according to AWS D1.4/D1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.06 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

a. Perform saw-cutting before concrete starts to cool, as soon as the concrete surface is firm enough not to be torn or damaged by the blade, and before random drying-shrinkage cracks can from in the concrete slab. Joints produced by conventional dry- or wet-cut process shall be made within 4 hours in hot weather and within 12 hours in cold weather after the slab has been finished.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint or use PVC dowel bar sleeve.

3.07 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Deviation from cross sectional thickness of suspended slabs shall not exceed ±1/4”.
   5. Deviation from elevation of suspended slabs before removal of supporting shores shall not exceed +3/8” nor -1/4”.
   6. Slope surfaces uniformly to drains where required.
   7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:
   1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.08 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
   1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.09 FINISHING FLOOR AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, or built-up or membrane roofing.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
   2. Finish surfaces to the following tolerances, according to ASTM E1155, for a randomly trafficked floor surface:
      a. Specified overall values (SOV) of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values (MLV) of flatness, F(F) 17; and of levelness, F(L) 15.

b. Specified overall values (SOV) of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values (MLV) of flatness, F(F) 24; and of levelness, F(L) 17; for surfaces to receive thin-set flooring.

3. For floor installations 10,000 sq. ft. or less in total project area, finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch (90 percent compliance) in accordance to ACI 117 Section 4.8.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive aluminum granule finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
1. Uniformly spread 25 lbs./100 sq. ft. of dampened slip-resistive aluminum granules over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aluminum granules.

H. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows.
1. Uniformly apply dry-shake floor hardener at a rate of 100 lbs./100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as

specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials.
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.12 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply liquid to concrete sooner than that recommended by manufacturer.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
   4. Repair technique shall be tested on a mockup or surface to be concealed later, before repairing surfaces exposed to view, for approval by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective

areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified Testing Agency to perform field tests and inspections and prepare test reports.

B. Inspections: Verify and inspect concrete Work as shown on Drawings.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least one random composite sample for each 50 cu. yd. of concrete or 2,000 sq. ft. of surface area of slabs of walls, or fraction thereof, of each concrete mixture placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C231/C231M, pressure method, for normal-weight concrete; [ASTM C173/C173M, volumetric method, for structural lightweight concrete;]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
   5. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   6. Compression Test Specimens: ASTM C31/C31M.

a. Mild-Reinforced Slabs and Beams: Cast and laboratory-cure five standard cylinder plus one spare standard cylinder specimens for each composite sample.
    1) Cast and field-cure additional standard cylinder specimens to verify concrete strength for removal of shoring and reshoring in multistory construction. Number of field-cured cylinder specimens to be determined by Contractor.
b. Walls and Columns: Cast and laboratory-cure five standard cylinder plus one spare standard cylinder specimens for each composite sample.
c. Other Concrete Elements: Cast and laboratory-cure four standard cylinder plus one spare standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39/C39M.
    a. Mild-Reinforced Concrete Slabs and Beams: Test one laboratory-cured specimen at 4 days; one laboratory-cured specimen at 7 days or upon formwork stripping, whichever comes first; one laboratory-cured specimen at 14 days; and two laboratory-cured specimens at 28 days.
    b. Walls, Columns and concrete pilaster: Test one laboratory-cured specimen at 7 days, one laboratory-cured specimen at 56 days and one laboratory-cured specimen at 90 days; and two laboratory-cured specimens at 28 days.
    c. Other Concrete Elements: Test two laboratory-cured specimens at 7 days and two laboratory-cured specimens at 28 days.
    d. A compressive-strength test at shall be the average compressive strength from a set of two specimens obtained from same composite and tested at the age indicated.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
    a. If 28-day compressive-strength test falls below satisfactory levels, strength test the spare cylinder at age determined by the Contractor and average with the strength of the 28-day specimens. The average strength of the three cylinders shall be considered one compressive-strength test.
9. Modulus of Elasticity Test Specimens: ASTM C31/C31M.
    a. Shear walls,columns and concrete pilasters: Cast and field-cure eight two standard cylinder specimens plus two spares for each composite sample.
        1) Composite samples (consisting of 10 standard field-cured cylinder specimens) for each concrete strength, each concrete mix design and for each aggregate source, shall be randomly selected from every five floors, with two random composite samples minimum per building.
10. Modulus of Elasticity Tests: ASTM C469/C469M. Modulus of elasticity to be tested using servo controlled electromechanical United machines or servo controlled hydraulic Satec machines. Maintain rate of loading to 35 ± 4 psi in lieu of that specified in ASTM C469/C469M.

1. Mild-Reinforced and Post-Tensioned Slabs and Beams: Test two field-cured specimens at 2 days, 4 days, 7 days, 14 days, and 28 days.
2. Columns and Shear Walls: Test two field-cured specimens at 7 days, 28 days, 56 days, and 90 days.
3. A modulus of elasticity test shall be the average modulus of elasticity from a set of two specimens obtained from same composite sample and tested at age indicated.
4. If modulus of elasticity of two specimens varies by more than 15% a spare cylinder shall be tested. The average modulus of elasticity of three specimens shall be considered the modulus of elasticity.
5. Modulus of elasticity tests are required for each concrete strength, each concrete mix design and for each aggregate source.

11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing.
    a. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete Testing Agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for each age tested.
    b. Reports of modulus of elasticity tests shall contain Project identification name and number, mix identification number, specimen identification number, curing and environmental history of specimen, date of test, name of Testing Agency, and plot of the results with age of concrete as the abscissa and modulus of elasticity as the ordinate.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing Agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E1155 within 24 hours of finishing.

3.16 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 03 35 03 - CONCRETE SLAB FINISHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Concrete finish requirements for unformed horizontal concrete surfaces. This section supplements requirements of Division 03 Section "Cast-In-Place Concrete."

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for sealers, indicating VOC content.
   2. Documentation for sealers, indicating compliance with emissions testing or certification.

1.04 QUALITY ASSURANCE

A. Standards: Comply with the following documents, except where requirements of the contract documents are more stringent:
   1. ACI 301.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Sealers:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.02 CONCRETE SLAB SEALER

A. Concrete Slab Sealer: Liquid chemical hardener; enhanced silicate or siliconate type.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Manufacturers: Subject to compliance with requirements**,** available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Curecrete Chemical; Ashford Formula.
   b. Dayton Superior; Sure Hard Densifier J17.
   c. Laticrete; L&M Lion Hard.

2.03 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified product that can be applied in thicknesses from a feathered edge to 1/2 inchto match adjacent floor elevations.
   1. Manufacturers: Subject to compliance with requirements**,** available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ardex; Feather Edge.
      b. Dayton Superior; Sure Finish.
      c. Laticrete; Supercap.
   2. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   3. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   4. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
   5. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inchand that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Manufacturers: Subject to compliance with requirements**,** available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ardex.
      b. Dayton Superior.
      c. Laticrete.
   2. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   3. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   4. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   5. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.04 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Contraction Joint Filler:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Sealant: As specified in Section 07 92 00.

B. Concrete Cleaner: Liquid concentrate, biodegradable, heavy-duty cleaner-degreaser compound.

PART 3 - EXECUTION

3.01 FINISHING SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
   1. Apply scratch finish to surfaces as follows:
      a. To receive concrete floor toppings.
      b. To receive mortar setting beds for bonded cementitious floor finishes.
      c. Other surfaces indicated.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces as follows:
      a. To receive trowel finish.
      b. To be covered with fluid-applied or sheet waterproofing,.
      c. Other surfaces indicated.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply trowel finish to surfaces as follows:
      a. Exposed to view.
      b. To receive concrete sealer.
      c. To receive polishing.
      d. To be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage/waterproofing/crack-isolation membrane, paint, or another thin-film-finish coating system.
      e. Other surfaces as indicated.
   2. Finish surfaces to the following Specified Overall Value (SOV) and Minimum Local Value (MLV) tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
      a. Carpeted Floors: Specified overall values of flatness, F(F) 25; and of levelness, F(L) 17; with minimum local values of flatness, F(F) 20; and of levelness, F(L) 15.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Polished Concrete Floors: Specified overall values of flatness, F(F) 40; and of levelness, F(L) 30; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 20.
c. Noncritical Floors: Specified overall values of flatness, F(F) 25; and of levelness, F(L) 17; with minimum local values of flatness, F(F) 20; and of levelness, F(L) 15.
1) Floors Include: Exposed concrete slabs in nonpublic areas, subfloors under concrete topping slabs, and slabs scheduled for mortar beds.
d. Other Floors at Slabs on Grade: Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
e. Other Floors at Suspended Slabs: Specified overall values of flatness, F(F) 35; and of levelness, F(L) 24; with minimum local values of flatness, F(F) 20; and of levelness, F(L) 15; for suspended slabs.

3. F(L) tolerances do not apply to randomly trafficked floor surfaces that are inclined or cambered.
4. F(L) tolerances do not apply to shored, elevated construction after shoring has been removed.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Apply trowel and fine broom finish to surfaces as follows:
a. To receive ceramic or quarry tile installed by either thickset or thin-set method.
b. To receive traffic coatings.
c. Exposed interior stair treads/landings, steps, and ramps.
d. Other surfaces indicated.
2. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
1. Apply broom finish to surfaces as follows:
a. Exterior concrete platforms, steps, and ramps.
b. Other surfaces indicated.

G. Float and Broom Finish: After applying float finish, begin second floating operation to surfaces when bleed water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations and apply broom finish as follows:
1. Apply float and broom finish to surfaces as follows:
a. Parking garage slabs and ramps.
2. Apply a fine broom finish at parking garage slabs by drawing a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Apply a coarse broom finish at parking garage ramps and turns by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.02 REPAIRING SLAB SURFACES

A. Repairing Unformed Surfaces:
   1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
      a. Correct low and high areas.
      b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   3. After concrete has cured at least 14 days, correct high areas by grinding.
   4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
      a. Finish repaired areas to blend into adjacent concrete.
   5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
      a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
      b. Feather edges to match adjacent floor elevations.
   6. Correct other low areas scheduled to remain exposed with repair topping.
      a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
      b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
      a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
      b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
      c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
      d. Place, compact, and finish to blend with adjacent finished concrete.
      e. Cure in same manner as adjacent concrete.
   8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
b. Dampen cleaned concrete surfaces and apply bonding agent.
c. Place patching mortar before bonding agent has dried.
d. Compact patching mortar and finish to match adjacent concrete.
e. Keep patched area continuously moist for at least 72 hours.

B. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

C. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.03 SEALED CONCRETE FLOORS

A. Concrete Slab Sealer:
1. Apply sealer/finish following manufacturer's printed application instructions; apply single saturation coat.
2. Remove surplus sealer/hardener and rinse according to manufacturer's instructions.
3. Burnishing: Prior to substantial completion, apply light second coat of chemical sealer-hardener material and polish using mild abrasives or brushes in accordance with sealer/hardener manufacturer's recommendations. Buff to even satin sheen.
4. Location: At all interior, exposed slabs subject to pedestrian traffic, unless indicated otherwise.

3.04 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
1. Coordinate floor and slab flatness and levelness testing with Owner's testing agency according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 03 35 43 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Polished concrete finishing.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 03 30 00 "Cast-in-Place Concrete" for concrete for polished concrete, including concrete materials, mixture design, placement procedures, and curing.
   3. Section 03 35 03 "Concrete Slab Finishing" for flatness and levelness requirements, and initial finishing for polished concrete.
   4. Section 07 92 00 “Joint Sealants” for sealants installed with polished concrete flooring.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to polished concrete finishing including, but not limited to, the following:
      a. Inspect and discuss condition of substrate and other preparatory work including concrete repair procedures.
      b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, and equipment.
      c. Review special designs and patterns.
      d. Review protection of polished concrete.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints and divider strips, including construction joints.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for liquid floor treatments, indicating VOC content.

B. Product Test Reports:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Slip-resistance test reports from qualified independent testing agency.

C. Qualification Data: For Installer.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A company experienced in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce specified work.

B. Mockups: Before casting concrete, build mockups to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Demonstrate curing, finishing, and protecting of polished concrete.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Liquid Floor Treatments:
a. VOC content limits for field applications.

2.02 PERFORMANCE REQUIREMENTS

A. Slip Resistance, Coefficient of Friction: Provide flooring with the following values as determined by testing identical products in accordance with the following:
1. Level Surfaces, Dry and Wet: DCOF of not less than 0.42 in accordance with ANSI A326.3.

2.03 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering systems that may be incorporated into the Work include, but are not limited to, the following:
1. Advanced Floor Products; RetroPlate System.
2. Diamatic USA; ULTRAFLOOR Premium System.
3. HTC LLC; Superfloor System.
4. Husqvarna Construction Products; Hiperfloor System.
5. The Bomanite Company; Bomanite Custom Polishing System.
6. W.R. Meadows; Induroshine System.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 MATERIALS

A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

B. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.

C. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.

2.05 MISCELLANEOUS ACCESSORIES

A. Divider Strips:
1. Material: As indicated.
2. Top Width: As indicated.

B. Divider Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use.

PART 3 - EXECUTION

3.01 APPLICATION, GENERAL

A. Place, rough grind, fine grind, and finish according to manufacturer's written instructions.

B. Divider Strips:
1. Sawcut recess for and locate divider strips in locations indicated.
2. Install strips in adhesive setting bed without voids.

C. Ensure that fluids from grinding operations do not stain floor by reacting with divider strips.

3.02 POLISHING

A. Apply polished concrete finish system to cured and prepared slabs.
1. Machine grind floor surfaces to receive polished finishes level and smooth.
2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
3. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.
4. Control and dispose of waste products produced by grinding and polishing operations.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

5. Neutralize and clean polished floor surfaces.

B. Aggregate Exposure Class: In accordance with ASCC's Concrete Polishing Council, based on visual observation of the overall area of the polished floor as indicated on drawings, and as follows:
   1. Class A, Cement Fines: Surface exposure of 85 to 95 percent cement fines and 5 to 15 percent fine aggregate.
   2. Class B, Fine Aggregate: Surface exposure of 85 to 95 percent fine aggregate and 5 to 15 percent cement fines and coarse aggregate.
   3. Class C, Course Aggregate: Surface exposure of 80 to 90 percent coarse aggregate and 10 to 20 percent cement fines and fine aggregate.

C. Polished Concrete Appearance Level: In accordance with ASCC's Concrete Polishing Council, with haze index less than 10 in accordance with ASTM D4039, as indicated on drawings, and as follows:
   1. Level 1, Flat (Ground):
      a. Distinctness-of-Image Gloss; ASTM D5767: Less than 9 percent.
      b. Procedure: Not less than 4 step process with full refinement of each resin-bonded diamond pad with one application of densifier.
      c. Grit Range: 100 or less.
   2. Level 2, Satin (Honed):
      a. Distinctness-of-Image Gloss; ASTM D5767: Between 10 and 39 percent.
      b. Procedure: Not less than 5 step process with full refinement of each resin-bonded diamond pad with one application of densifier.
      c. Grit Range: 100-400.
   3. Level 3, Polished:
      a. Distinctness-of-Image Gloss; ASTM D5767: Between 40 and 69 percent.
      b. Procedure: Not less than 6 step process with full refinement of each resin-bonded diamond pad with one application of densifier.
      c. Grit Range: 800 and higher.
   4. Level 4, Highly Polished:
      a. Distinctness-of-Image Gloss; ASTM D5767: Greater than 70 percent.
      b. Procedure: Not less than 7 step process with full refinement of each resin-bonded diamond pad with one application of densifier.
      c. Grit Range: 800 and higher.

3.03 CLEANING AND PROTECTION

A. Cleaning:
   1. Remove grinding dust from installation and adjacent areas.
   2. Wash surfaces with cleaner according to manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.

B. Protection: Provide final protection and maintain conditions that ensure that polished concrete floor is without damage or deterioration at time of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 04 21 13.23 SURFACE-BONDED BRICK MASONRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Thin brick wall system.

B. Related Sections:
   1. Section 07 19 00 "Water Repellents" for water repellents applied to thin brick wall assemblies.
   2. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product data. For each type of product, and as follows:
   1. Thin Brick Units: Indicate sizes, profiles, coursing, and locations of special shapes.

B. Shop Drawings: Show locations, plans, and elevations, of each type of thin brick and thin brick pattern. Show widths, details, and locations of movement joints in thin brick substrates and finished thin brick surfaces.

C. Samples for Verification: For each type and color of the following:
   1. Thin brick.

1.04 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include material test reports substantiating compliance with requirements.
      b. For thin brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      c. For exposed thin brick, include test report for efflorescence in accordance with ASTM C67/C67M.

1.05 MOCKUPS

A. Wall Mockups: Build mockups to verify selections made under Sample submittals,to demonstrate aesthetic effects, and to set quality standards for materials and execution.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Build mockup for typical exterior wall approximately 60 inches long by 48 inches high.
   a. Include a sealant-filled movement joint at least 16 inches long.
   b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
   c. Include wall studs, sheathing, weather barrier, continuous exterior insulation, cement mortar bed, cleavage membrane, and waterproofing membrane in exterior wall mockup.
2. Protect accepted mockups from the elements with weather-resistant membrane.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.07 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.08 WARRANTY

A. Manufacturer's Special Warranty: Mortar and waterproofing materials manufacturer agrees to repair or replace components of surface-bonded brick masonry wall assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Bond integrity and weathertightness.
      b. Deterioration of surface-bonded brick assembly materials beyond normal weathering.
   2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

A. For exposed masonry units, obtain each color and grade from single source with resources to provide materials of consistent quality in appearance and physical properties.

B. Source Limitations: Obtain surface-bonded brick masonry system materials, including cement mortar base, waterproofing membrane, setting mortar, pointing mortar, and other materials required for a complete system from single source from single manufacturer. Obtain secondary materials, including metal lath and cleavage membrane, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.02 PRODUCTS, GENERAL

A. Masonry Standard: Comply with TMS 602, 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects will be exposed in the completed Work.

C. ANSI Standards for Thin Brick Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.03 THIN BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels.

B. Clay Thin Brick: Complying with ASTM C1088, Grade Exterior, Type TBX .
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or a comparable product by one of the following manufacturers:
   a. H.C. Muddox.
   b. Interstate Brick.
   c. Pacific Clay Products, Inc.
2. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
3. Size (Actual Dimensions): As indicated on drawings .
4. Thickness: 5/8 thick.
5. Color and Texture: As selected by Architect from manufacturer’s full range.

2.04 WATERPROOF MEMBRANES

A. General: Manufacturer's standard product that complies with ANSI A118.10 and ANSI A118.12 and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Physical Properties: Provide waterproofing membrane with the following minimum physical property requirements when tested in accordance with test methods indicated:
1. Fastener Sealability: Passes, with no leaks in accordance with ASTM D1970.
2. UV Exposure: Passes with no sign of failure in accordance with ICC Acceptance Criteria AC212.
3. UV Resistance: Can be exposed to sunlight for 90 days in accordance with manufacturer's written instructions.
4. Vapor Permeance: Maximum 1.00 perm; ASTM E96/E96M, B, Water Method.

C. Waterproof Membrane, Fluid-Applied: Liquid-latex rubber or elastomeric polymer.
1. Basis-of-Design Product: Subject to compliance with requirements, provide "MVIS Air and Water Barrier" by Laticrete International, Inc. or comparable product by one of the following:
   a. MAPEI Corporation.
   b. Custom Building Products.

2.05 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set): Product meeting requirements of ANSI A118.4 and specifically formulated for exterior use with surface-bonded brick masonry.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Basis-of-Design Product: Subject to compliance with requirements, provide "MVIS Hi-Bond Veneer Mortar" by Laticrete International, Inc. or comparable product by one of the following:
   a. MAPEI Corporation.
   b. Custom Building Products.
   c. TEC; a subsidiary of H. B. Fuller Company.

2.06 POINTING MORTAR MATERIALS

A. Latex Portland Cement Pointing Mortar: Weather, frost and shock resistant.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide "MVIS Premium Pointing Mortar" by Laticrete International, Inc. or comparable product by one of the following:
      a. MAPEI Corporation.
      b. Custom Building Products.
      c. TEC; a subsidiary of H. B. Fuller Company.
   2. Compressive Strength: ASTM C91: ≥4100 psi.

B. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.

C. Water: Potable.

2.07 ACCESSORIES

A. Metal Lath: ASTM C847; Galvanized, diamond metal lath; flat expanded type, weighing not less than 3.4 lb/sq. yd. with factory applied paper backing.
   1. Paper Backing: Vapor-permeable paper, factory bonded to back of lath; complying with requirements in FS UU-B-790a for Type I, Grade D and with 60-minute water resistance.

B. Cleavage Membrane: Installer's option of material that complies with mortar manufacturer's recommendations.

C. Latex Portland Cement Mortar:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc.; MVIS Premium Mortar Bed, or comparable product by one of the following:
      a. MAPEI Corporation.
      b. Custom Building Products.
      c. TEC; a subsidiary of H. B. Fuller Company.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting thin brick are firm; dry; clean; free of coatings that are incompatible with setting materials; and comply with flatness tolerances required by manufacturer and ANSI A108.01 for installations indicated.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove coatings, including curing compounds or other coatings, that are incompatible with setting materials.

B. Blending: For thin brick exhibiting color variations, verify that think brick has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend thin brick at Project site before installing.

3.03 CEMENT MORTAR BED INSTALLATION

A. Install metal lath in compliance with ANSI A108.01, ANSI A108.02, and ANSI A108.1B. Apply latex-portland cement mortar in a scratch and leveling coat over lath in compliance with ANSI A108.01 and ANSI A108.1B. Float surface of scratch and leveling coats plumb and true and allow mortar to cure for 72 hours at 70 degrees Fahrenheit.

3.04 INSTALLATION OF WATERPROOF MEMBRANE

A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
   1. Verify that wet-film thickness complies with requirements periodically with a wet film gauge in accordance with manufacturer’s recommendations.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.05 INSTALLATION OF THIN BRICK SYSTEM

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

C. Install latex portland cement mortar in compliance with ANSI A108.02 (3.11), A108.1B, ANSI A108.5, and manufacturer's instructions.
   1. Rake out mortar joints for pointing with sealant and mortar in accordance with setting mortar manufacturer's recommendations.

D. Bond Pattern: Unless otherwise indicated, set exposed masonry in bond pattern indicated on Drawings; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

E. Extend thin brick work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

F. Accurately form intersections and returns. Perform cutting and drilling of thin brick without marring visible surfaces. Carefully grind cut edges of thin brick abutting trim, finish, or built-in items for straight aligned joints. Fit thin brick closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

G. Provide manufacturer's standard trim shapes.

3.06 MORTAR POINTING

A. Point thin brick joints as follows:
   1. Clean joint surfaces by removing dust and mortar particles.
   2. Apply mortar in layers not greater than 3/8 inch until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
   3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
   4. When mortar is thumbprint hard, tool joints. Remove excess mortar from edge of joint by brushing.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

B. Pointing with Sealant at Movement Joints: Comply with Section 07 92 00 "Joint Sealants." and as follows:
1. Clean and prepare joint surfaces. Prime joint surfaces unless sealant manufacturer recommends against priming. Do not allow primer to spill or migrate onto adjoining surfaces.
2. Fill sealant joints with specified joint sealant.
a. Install sealant using only proven installation techniques that ensure that sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.
b. Install sealant as recommended in writing by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:
1) Fill joints to a depth equal to joint width, but not more than 1/2 inch deep or less than 1/4 inch deep.
c. Tool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant from surfaces adjacent to joint.
d. Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

C. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and thin brick. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing thin brick.

3.07 TOLERANCES

A. Lines and Levels:
1. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
2. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
4. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

B. Mortar Joints:
1. Do not vary from thickness indicated by more than plus or minus 1/8 inch.
2. For stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

05 31 00 - Steel Decking

05 50 00 – Metal Fabrications

09 22 16 - Non-Structural Metal Framing

1.02 SUMMARY

A. Section Includes:
1. Structural steel.
2. Grout.

B. Related Sections:
1. Division 05 Section "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.
2. Division 09 painting Sections and Division 09 Section " Non-Structural Metal Framing " for surface-preparation and priming requirements.

1.03 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SFRS" or elements along grid lines designated as "SFRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:
1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
2. Welded built-up members with plates thicker than 2 inches (50 mm).
3. Column base plates thicker than 2 inches (50 mm).

D. Protected Zone: Structural members or portions of structural members of the SFRS indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.04 ACTIONS SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.
1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand critical welds.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing. For demand critical welds include the following:

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:
1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.

6. Nonshrink grout.

F. Source quality-control reports.

1.06 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

D. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 358.
4. AISC 360.
5. RCSC "Specification for Structural Joints Using High Strength Bolts."
6. AWS D1.1/D1.1M.
7. AWS D1.8/D1.8M.

E. Preinstallation Conference: Conduct conference at Project site.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
1. Fasteners may be repackaged provided Owner's Testing Agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125 fasteners and for retesting fasteners after lubrication.

1.08 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL STEEL MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
1. W-Shapes: 60 percent.
2. Channels, Angles, M, S-Shapes: 60 percent.
3. Plates and Bars: 25 percent.
4. Cold-Formed Hollow Structural Sections: 25 percent.
5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.

B. W-Shapes: ASTM A 992/A 992M.

C. Channels, Angles, M-, S-Shapes: ASTM A 36/A 36M.

D. Plates and Bars: ASTM A 36/A 36M, typical (UNO); ASTM A 572/A 572M, Grade 50, when used in SLRS connection.

E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade C, structural tubing.

F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
1. Finish: Black (except where indicated to be galvanized).

G. Welding Electrodes: Comply with AWS requirements.

2.02 BOTLS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: : ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish; where indicated on drawings.
   1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM F3125, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
   1. Finish: Hot-dip or mechanically deposited zinc coating. All threaded components of the fastener assembly must be galvanized by the same process. Mixing high-strength bolts that are galvanized by one process with nuts that are galvanized by the other is not permitted.
   2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain.

E. Shear Connectors: ASTM A 108, Grades 1010 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

F. Headed Anchor Rods: ASTM F 1554, Grade 36, typical; ASTM F 1554, Grade 55, weldable, when used in SLRS; straight.
   1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel. Match rod grade.
   2. Plate Washers: ASTM A 36/A 36M carbon steel.
   3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   4. Finish: Plain.

G. Threaded Rods: ASTM A 36/A 36M.
   1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel. Match rod grade.
   2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   3. Finish: Plain.

H. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

K. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement along one or two axes.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.
   2. Mating Surfaces: PTFE and PTFE.
   3. Coefficient of Friction: Not more than 0.06 at 2,000 psi bearing pressure.
   4. Design Bearing Pressure: Not greater than 2,000 psi (13.7 MPa).

2.03 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers", including 2004 Addenda.

B. Primer: Comply with Division 09 painting Sections and Division 09 Section " Non-Structural Metal Framing."

C. Primer: SSPC-Paint 15, Type II, zinc oxide, alkyd, linseed oil primer.

D. Galvanizing Repair Paint: ASTM A 780.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC "Specification for Structural Joints Using High Strength Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless noted otherwise on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.07 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
   2. Surfaces to be field welded.
   3. Top flange of beams supporting steel decking.
   4. Surfaces to be high-strength bolted with slip-critical connections.
   5. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   6. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."

2. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.08 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

3.02 PREPARATION

A. Determine, furnish and install all temporary supports, such as temporary guys, beams, braces, falsework, cribbing or other elements required for the erection operation. These temporary supports shall be sufficient to secure the bare structural steel framing or any portion thereof against loads that are likely to be encountered during erection, including those due to wind and those that result from erection operations. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC "Specification for Structural Joints Using High Strength Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened unless noted otherwise on Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.05 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified independent Testing Agency to inspect field welds and high-strength bolted connections and prepare test reports.

B. Inspections: Verify and inspect structural steel Work as shown on Drawings.

C. Bolted Connections: Bolted connections will be tested and inspected according to RCSC "Specification for Structural Joints Using High Strength Bolts."

D. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
   1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at Testing Agency's option:
      a. Liquid Penetrant Inspection: ASTM E 165.
      b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
      c. Ultrasonic Inspection: ASTM E 164.

E. SFRS Connections: Test and inspect SFRS connection elements as indicated in accordance to AISC 341, AWS D1.1/D1.1M and AWS D1.8/D1.8M.

F. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Testing Agency, where warranted, may select a reasonable number of additional studs to be subjected to the bend tests.

G. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION

SECTION 05 12 50 – BUCKLING RESTRAINED BRACES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes:
   1. Furnishing Buckling Restrained Braces (BRB's).
   2. Engineering design of BRB's.

B. Related Sections:
   1. Division 05 Section “Structural Steel Framing” for installation of BRB's and furnishing of connection hardware for BRB's, including loose plates and fasteners.

1.03 REFERENCES

A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

B. ASTM: Standards of the American Society for Testing and Materials (ASTM) apply where designated in this Section. Use applicable year of adoption or revision as published in the “Annual Book of ASTM Standards”.

C. American Institute of Steel Constructions.
   1. ANSI/ AISC 341: Seismic Provisions for Structural Steel Buildings.
   2. ANSI/ AISC 360: Specification for Structural Steel Buildings.

D. American Welding Society.
   1. AWS C4.1: Criteria for Describing Oxygen-Cut Surfaces and Oxygen Cutting Surface Roughness Gauge, latest edition.
   2. AWS D1.1: Structural Welding Code.
   3. AWS D1.8: Structural Welding Code – Seismic Supplement. (Comply with the requirements of AISC 303, AISC 341, and AISC 360 except where the additional or more stringent requirements of AWS D1.8 are shown or specified in this Section).

E. Research Council on Structural Connections.

1. RCSC Specification: Specification for Structural Joints Using ASTM A325 or A490 Bolts.

F. SSPC: Latest edition of Society for Protective Coatings surface preparation and painting specifications apply where cited in this Section.

1.04 DEFINITIONS

A. Buckling Restrained Brace (BRB): Specialty structural brace element consisting of an axial force resisting steel core encased by a system that prevents buckling of the steel core.
1. Tension and compression shall be resisted entirely by the steel core. The buckling restraining system shall prevent brace buckling and control plate buckling without restraining the steel core from longitudinal extension and shortening for deformations corresponding to two (2.0) times the design story drift.

1.05 DESIGN AND PERFORMANCE REQUIREMENTS

A. Physical Requirements:
1. The net area of the steel core shall be as designated on the Drawings.
2. The casing shall not exceed the maximum dimensions designated on the Drawings, without written approval of Owner's Representative.

B. Performance Criteria:
1. Braces shall provide for stable cyclic displacement (lengthening and shortening), corresponding to the acceptance criteria of ANSI/ AISC 341, Section K.3.
a. The axial brace deformation, $\Delta_{bm,}$ corresponding to the design story drift, shall be as designated on the Drawings.

C. Design Requirements:
1. Manufacturer's Engineer shall design braces to achieve the Performance Criteria. Design shall be based on detailed examination and understanding of the results of qualifying cyclic tests and interpolation of results to project conditions.
2. Interpolation of test results for different member sizes shall be justified by rational analysis that demonstrates stress distributions and magnitudes of internal strains that are consistent with or less severe than the tested assemblies and that considers the adverse effects of larger material and variations in material properties. Consider the effect of imposed end rotations.

D. Qualification Tests: The design of braces shall be based on results from qualifying cyclic tests. Tests shall consist of at least two successful cyclic tests: one is required to be a test of a brace subassemblage that includes brace connection imposed rotations and the other may be either a uniaxial or subassemblage test.
1. Qualification tests shall conform to requirements of ANSI/ AISC 341, Section K.3.

2. Qualification tests are permitted to be based on documented full-scale cyclic tests performed for other projects or tests reported in research, provided that there is sufficient basis for extrapolation to project conditions.

1.06 SUBMITTALS

A. Qualification Testing Report: Conform to requirements of ANSI/AISC 341, Section K.3.

B. Certified Manufacturer's Quality Assurance Plan: Conform to requirements of "Quality Assurance".

C. Brace Design: Submit drawings and calculations signed by the Manufacturer's Engineer.
1. Design Drawings: Show size and configuration of steel core for full length of BRB. Indicate casing size and length. Provide details of welding.

D. Certified material test reports: Submit to Owner's Testing Laboratory for record purposes.
1. Steel.
2. Welding filler material.
3. Coupon tests for core plate steel.

E. Erection Drawings: Show location and size of BRB's. Give complete information necessary for fabrication of elements of structural steel frame to receive braces and fabrication of connection plates. Show methods of assembly, including type and size of bolts, hole diameter, and preparation and finish of faying surfaces. Identify tolerances for fabrication and erection.

F. Testing and Inspection Reports: Submit Quality Assurance test and inspection reports to Testing Laboratory for record purposes prior to shipping of braces.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Shall have manufactured and successfully tested braces of sizes required for this project.

B. Design Engineer Qualifications: Structural Engineer, registered in the State of California, that is knowledgeable with the results of cyclic testing of BRB's and experienced in the design of BRB's based on engineering analysis.
1. Engineer may be an employee of brace manufacturer.

C. Quality Assurance Plan: Manufacturer shall have a detailed Quality Assurance Plan to evidence that the BRB's being manufactured are of same quality as those tested.

D. Qualification Testing: Refer to Article 1.05 D, "Qualification Tests" for requirements.

1. Extrapolation of Qualification Testing: All deviations from materials, details of fabrication, and quality assurance controls used for the fabrication of tested prototype braces shall be identified by manufacturer and reviewed by Design Engineer to ensure that production braces meet or exceed the level of quality used in fabrication of prototype braces.

E. Coupon Testing:
   1. Randomly sample and tension test steel plate for brace core in accordance with ASTM E8, plate-type tests.
   2. Take samples from plates at point of brace manufacture.
      a. The axis of the test specimens shall be parallel to the axis of the brace core; no testing transverse to axis of brace core is required.
      b. The end of the test specimen shall be located 6 inches minimum from the end of plate.
      c. The centerline of the test specimen shall be located at the center of steel bars and not closer than 8 inches to a rolled edge of plate.
   3. Test a minimum of 3 specimens for each plate thickness, spaced sufficiently to be representative of the plate employed in the work.
      a. Where more than one heat is employed, test a minimum of 3 specimens from each heat of steel.
      b. Test 2 additional specimens whenever an individual test varies by more than 5 percent from the average of 3 specimen tests.
   4. When the average yield (at 0.2% offset) for a sample falls outside of the specified tolerances, the steel shall be rejected for use on the project.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

A. The following manufacturer's, which have successfully completed qualification testing of braces similar to those required for the project, will be considered acceptable manufacturers, subject to compliance with other requirements of the Contract Documents, including limitations on maximum brace dimensions.
   1. Corebrace, West Jordan, Utah.

2.02 MATERIALS

A. Steel Plate for Core: ASTM A36, ASTM A572, Grade 42; except that tensile yield stress at 0.2% offset shall be 38 ksi minimum to 46 ksi maximum, as evidenced by coupon testing.
   1. Steel plates 2 inches (50 mm) and thicker shall be supplied with Charpy V-Notch testing in accordance with ASTM A6 Supplementary Requirement S5, or approved equal. The impact test shall meet a minimum average value of 20 ft-lbs absorbed energy at +70 degrees F when tested in accordance with ASTM A673, Frequency P.

B. Casing: ASTM A500, Grade B.

C. Welding Filler Material: All welds used in the fabrication of the braces shall be considered Demand Critical Welds. Conform to requirements of AISC 341 Section A3.4b and the additional requirements of AWS D1.8, Section 6.3; subject to meeting the CVN toughness and elongation of filler material used for fabrication of tested assemblies.

D. Shop Primer: Manufacturer's standard zinc-rich rust preventative primer.
1. Type A Primer: SSPC-Paint 25, Type II, iron oxide, raw linseed oil and alkyd.
2. Type B Primer: SSPC-Paint 20, Type II. Organic, zinc-rich primer; containing less than 0.002% lead. Acceptable Products: Series 90-97 Tneme-Zinc by Tnemec, Carbozinc 621 by Carboline, or approved equal.

E. Debonding Agent: Manufacturer's standard; demonstrated suitable to maintain separation of steel core and grout encasement when subjected to a minimum of 30 cycles of inelastic yielding at 2.0 percent strain; resistant to aging effects for a life cycle of 50 years.

F. Fill Material: Manufacturer's standard cementitious grout; demonstrated suitable for function as a confining in-fill material by subassemblage qualification testing.
1. Grout shall have a minimum compressive strength of 3000 psi at 28 days ASTM C109).

2.03 FABRICATION

A. Fabricate steel in accordance with Division 05 Section, "Structural Steel Framing" for members part of the Seismic Load Resisting System.

B. Core Plates.
1. Cut core plates to profile shown on manufacturer's design drawings. Conform to tolerances of manufacturer's Quality Assurance Manual, except tolerance on plate width shall not exceed plus or minus 0.2 inches (5 mm.
2. Axis of core plates shall be parallel to rolling direction of steel plate.
3. Splices in the steel core shall not be permitted.
4. Roughness: After cutting, edges of core plates shall have surface finish better than Sample 3, AWS C4.1.
5. Gouges and Notches: Occasional gouges and notches less than 0.2 inches (5 mm) deep in edges of core plates may be repaired by grinding to a smooth transition. The length of transition shall be a minimum of 10 times the depth of gouge. The area shall be inspected by MT after grinding to ensure the entire depth of gouge has been removed. Deeper gouges shall be cause for rejection of piece.
6. Welding: Continuously weld intersections of cruciform plates. The detailing and finishing of weld terminations shall meet or exceed quality of tested assembly.

C. Holes: Holes for bolted connections shall be drilled and burrs removed. Provide oversize holes for brace connections conforming to requirements of ANSI/ AISC 360. Holes for pins shall be cut and finished in accordance with manufacturer's approved procedures.

D. Assembly: Assemble components of the Buckling Restrained Brace in a manner to ensure proper performance of the brace.
   1. Examine steel core areas for straightness prior to coating with debonding agent.
   2. Provide end-confining plates to ensure confinement of the fill material while allowing for non-restricting movement of the steel core.

E. Finishes: Except as otherwise designated on Drawings, conform to the following finish and painting schedule, in accordance with requirements of Division 05 Section, Structural Steel:
   1. Interior, concealed by finishes or spray fireproofed: SSPC-2 surface preparation; no shop primer paint, or at brace manufacturer's option surfaces may be shop primed with manufacturer's standard shop primer, except faying surfaces of bolted connections and surfaces to receive spray fireproofing.
   2. Interior, exposed and finish painted: SSPC-6 surface preparation; shop paint with Type A primer, except at faying surfaces of bolted connections.

2.04 SOURCE QUALITY CONTROL

A. Inspection and testing will be performed under in accordance with procedures and administrative requirements of Division 01 Section "Quality Requirements".

B. Owners Testing Agency will:
   1. Review Manufacturer's Quality Assurance Plan, mill certificates and coupon test report.
   2. Review Manufacturer's quality assurance test and inspection reports.

C. Contractor shall:
   1. Notify Owner's Representative no less than 30 days before the start of fabrication of the buckling restrained braces, to allow Owner's Representative to observe fabrication and assembly process.
   2. Perform testing and inspection in accordance with approved Quality Assurance Plan and requirements of Contract Documents.

PART 3 - EXECUTION

3.01 ERECTION

A. Braces are erected under Division 05 Section, "Structural Steel Framing.'

B. Prior to erection, clean faying surfaces of brace to be in contact with bolted connections to remove temporary coatings applied for transport and surface contaminants.

C. Buckling restrained braces shall not be field cut or altered. Alterations to structural steel components to receive Buckling Restrained Braces shall be as permitted by Division 05 Section “Structural Steel Framing.”

D. No field welding to buckling restrained brace members will be permitted, including attachment of nonstructural components.

END OF SECTION

SECTION 05 31 00 – STEEL DECKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   1. 03 00 00 Cast-in-Place Concrete
   2. 05 12 00 Structural Steel

1.02 SUMMARY

A. Section Includes:
   1. Roof Deck
   2. Composite floor deck.

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
   2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
   3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:
   1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. ICC-ES Evaluation Reports: For steel deck.

1.05 QUALITY ASSURANCE

A. AISI “North American Specifications for the Design of Cold-Formed Steel Structural Members” (S100).

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel.”

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members.”

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Required fire-resistive ratings are as indicated.
2. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

2.02 ROOF DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating, UNO drawings.

2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: Triple span or more where possible.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.03 COMPOSITE FLOOR DECK

A. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating, UNO drawings.
2. Deck Profile: As indicated.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: Triple span or more where possible.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.
a. Uncoated steel deck 0.0474 inch thick (18 gage) or thicker shall not be overlapped where welded shear studs are attached through deck to supports.

2.04 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Vent Tabs: Provide factory punched vents projecting upwards in interior low flutes approximately 6 inches on center and providing 1-1/2 percent open area.

C. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0593-inch (16 gage) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi , not less than 0.0593-inch (16 gage) design uncoated thickness, of same material and finish as deck, and of profile indicated.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0593-inch (16 gage) design uncoated thickness, of same material and finish as deck unless otherwise indicated.

G. Galvanizing Repair Paint: ASTM A780/A780M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
   1. Warp deck permitted only where indicated.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.03 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
   1. Weld Diameter: 5/8 inch minimal (1/2 inch effective).
   2. Weld Spacing: Space and locate welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches, and as follows:

1. Mechanically clinch or button punch.
2. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:
1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.04 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
1. Weld Diameter: 5/8 inch, nominal (1/2 inch effective).
2. Weld Spacing: Space and locate welds as indicated.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
1. Mechanically clinch or button punch.
2. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:
1. End Joints: Lapped or butted at Contractor's option.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.06 PROTECTION

A. Do not use deck units for storage or working platforms until permanently secured in position.

B. Construction loads must not exceed carrying capacity of deck.

C. Concrete must be placed with care, avoiding impacts by dropping or dumping. Runways must be planked if using buggies or wheelbarrows. Heavy concentrated loads of concrete or crew and uniform loads exceeding 20 psf must be invested for shoring construction.

D. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

E. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 40 00 – COLD FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Load-bearing cold-formed structural steel studs.

B. Interior wall framing using Cold Formed Metal Framing at plumbing walls, wall openings and cabinet-supporting walls.

C. Formed steel accessories.

D. Related Sections:
   1. Section 07 21 00 “Thermal & Acoustical Insulation”.
   2. Section 09 21 16 “Gypsum Board Assemblies.”

1.02 REFERENCES

A. AISI – American Iron and Steel Institute.
   1. S100 – Design of Cold-Formed Steel Structural Members.
   2. S200 – Cold-Formed Steel Framing – General Provisions.
   3. S211 – Wall Stud Design.
   4. S212 – Header Design.
   5. S213 – Lateral Design.

B. ASTM International
   1. A 1003 – Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated.
   2. C 645 – Nonstructural Steel Framing Members.
   3. A653/A653M - Steel Sheet, Zinc-Coated (galvanized) or Zinc-Iron Alloy - Coated (Galvanized) by the Hot-Dip Process.
   4. C 754 – Installation of Steel Framing Members.
   5. C955 - Load-Bearing Steel Studs, Runners, and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
   6. C 1513 – Steel Tapping Screws for Cold-Formed Steel Framing Connections.

C. AWS D1.3 – American Welding Society, Structural Welding Code, Sheet Steel.

D. CBC California Building Code, Chapter 22A

1.03 SUBMITTALS

A. Provide product data on standard framing members. Describe materials and finish, product criteria, limitations and properties.

B. Mill certificates: signed by the steel sheet producer indicating steel sheet complies with requirements.
   1. Section 4-343: Duties of the Contractor.
   2. Section 4-342: Duties of the Project Inspector.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in steel studs framing and components with five years minimum experience.

B. Welding: welders certified by AWS.

1.05 OWNER OCCUPANCY

A. The Owner will occupy portions of the project as individual rooms become available for outfitting, furniture and fittings installation, and related start-up tasks.

PART 2 - PRODUCTS

2.01 FRAMING MATERIALS

A. Studs: ASTM A1003, Structural Grade 50, Type H (ST50H), sheet steel, formed to "wide flange" shape or "C" shape, punched web, 16 gauge (0.056”, SSMA designation 54) thick unless noted otherwise on drawings, 50 ksi steel unless noted otherwise on drawings, sizes required to conform to details and scheduled wall thicknesses, and as required for structural performance. Studs shall be rolled from new sheet steel and shall not be produced from re-rolled steel.
   1. Properties: As listed in manufacturer's standard tables for applicable grade of steel and sizes.
   2. Conform to AISI S100 and AISI S200.
   3. Coating: Zinc coated per ASTM A653, G60.

B. Track: ASTM A1003, Structural Grade 50, Type H, sheet steel, channel shaped, deep leg, 16 gauge (0.056”, SSMA designation 54) thick unless noted otherwise on drawings, 50 ksi steel unless noted otherwise on drawings, solid web, long leg at ceilings, profile to produce snug fit over adjacent components.
   1. Conform to S100 – Design of Cold-Formed Steel Structural Members.
   2. Approved pre-fabricated slotted slip track for top of wall: CEMCO Slotted Track (CST) 16 gauge, ICC ESR-2012 or equal as approved in accordance with Division 01, General Requirements for substitutions.
   3. Install in accordance with manufacturer’s recommendations and fire rating requirements.
   4. Coating: Zinc coated per ASTM A653, G60.

C. Slotted Fire Track: CEMCO FAS Track ASTM A1003, Structural Grade 33, Type H, cut steel channel shaped, deep leg, 16 gauge (0.056") thick unless noted otherwise on drawings, 33 ksi steel unless noted otherwise on drawings, solid web, long leg at ceilings, profile to produce snug fit over adjacent components. Track is designed with intumescent fire proofing on both sides of the track. Intumescent material to lap over the top of the track by 0.25" on each side of the track and down each leg 1.18" to an external groove. Slotted fire track shall be listed by UL Fire Resistance Directory as a firestop for the application used.

D. Fire Strap: CEMCO FAS Strap ASTM A653, Grade 33 with a minimum 33 ksi yield strength to span between flutes of metal decking. Fire strap to have a minimum of a 1-inch wide continuous strip of intumescent running parallel and along each edge of the strap. Fire strap shall be listed by UL Fire Resistance Directory as a firestop for the application used.

E. Header and Jambs: ClarkDietrich Building Systems, Heavy Duty Studs and Header Brackets.
   1. ProX Header, Brady Construction Innovations Inc. or equal where specified.

F. Stiffener U- Channels and Angles: Minimum Weights as Follows:
   1. 3/4 inch - .3 pound per foot, cold- or hot-rolled channel.
   2. 1-1/2 inches - .475 pound per foot, cold-rolled channel.
   3. 1-1/2 inches - 1.12 pounds per foot, hot-rolled channel.
   4. 2 inches - 1.26 pounds per foot, hot-rolled channel.
   5. 2 inches - .59 pound per foot, cold-rolled channel.
   6. 1-1/2 x 1-1/2 x 3/16 inch angle.

2.02 ACCESSORIES

A. Fastening: Self-drilling, Self-tapping Screws, ASTM C954, galvanized, Buildex/Tomarco Type S-12 point, low profile head screws #10 or equal, 1/2 inch long for two layers 16 gauge metal for non load-bearing framing, welded connections for load-bearing framing and for framing of 16 gauge studs and thicker.
   1. Welding: In conformance with AWS D1.3, minimum weld size 3/32".

B. Anchorage Devices, Powder Actuated:
   1. Install to conform to the load requirements of this Section ICC-ESR 2269 Hilti.
      a. Utilize tools as recommended by the manufacture in compliance with ICC numbers.
      b. ICC-ESR 2269 Hilti Inc., Fasteners – Manual, Pneumatic, or Powder-Driven Steel Studs and Nails.
   2. Allowable Loads: Limited 100 lbs. Maximum or 80% of ICC approved values. Testing required, refer to Division 01.

C. Anchorage Devices, Drilled Expansion Anchors:
   1. Wedge Type:

a. KWIK Bolt TZ2 Concrete Anchor, ICC ESR-4266, by Hilti Inc.

2. Adhesive Anchors System:
   a. For normal weight concrete, ICC ESR-3187, Hilti HIT-HY 200 Adhesive Anchor System.

D. Backings: Located and as indicated on drawings or 6” x 1-1/4” x 14 gauge flush mount backing, preformed with pre-punched screw holes, FLUSH-MOUNT BACKING by Metal-Lite, Inc., Anaheim, CA.

E. Track Bedding Sealant: Per Section 07 90 00 “Joint Protection”..

F. Wall finishes: Per Division 09 Finishes.

2.03 FINISHES

A. Galvanized Finish: Zinc coated per ASTM A653, G60.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify that substrate surfaces and building framing components are ready to receive work.

B. Beginning of installation means acceptance of existing conditions.

C. Layout markings shall not be made with xylene-based inks, paint, or dyes, or with other solvent-based products that may bleed through finishes.

3.02 ERECTION OFSTUDDING

A. Perform work in accordance with, AISI and SSMA/ICC ES - 3064P.

B. Align floor and ceiling tracks; locate to wall or partition layout. Secure in place with specified fasteners at spacing as indicated on drawings or maximum 32 inches on centers.
   1. Set floor track on continuous sealant, each side of track for exterior walls. Sealant type: Butyl Rubber per ASTM C920.
   2. Track Splices: notch flanges to allow sliding tracks past each another 12”. Attach as approved by manufacturer of system.

C. Place studs at 16 inches oc typically, or 12 inches oc in plumbing walls or as noted on drawings. Connect studs to tracks using fastener or welding method.

D. No flame (oxyacetylene) torch cutting is permitted, use Plasma Arc cutting to make penetrations for conduit or piping where required.

E. Construct corners using minimum three studs.

F. Install double (boxed) studs at each head, jamb and sill of each exterior and interior door and window opening. Extend studs from floor to underside of structure above. Weld all boxed jamb and header members with interrupted 1/8" welds, one inch long at 12 inches on center.

G. Install 1-1/2 inch standard steel furring channels at right angles to king stud at each door hinge point as permitted by perforations. Weld channel to four studs where possible.

H. Stiffeners: Install 3/4 inch standard steel furring channel stiffeners within 24 inches of top and bottom runners and at mid height of walls eight feet high. At higher walls, install stiffeners spaced maximum 48 inches on centers. Weld stiffeners to each stud and at laps.

I. In areas where a finish material occurs on one side of wall only, provide full width bridging or bracing. Two systems permitted.
   1. Install 3/4 inch x 16 gauge continuous brace through stud punch-outs, fastened to studs with angle clips welded or screw fastened, spaced as scheduled below
   2. Install 1-1/4 inch x 16 gauge strap, 3/4 inch x 16 gauge or cold-rolled channel continuous across unrestrained edges of studs spaced as scheduled below, screw fastened or welded to each stud, and connected to one blocking member screw fastened or welded to adjacent studs.

J. Bridging or Bracing Schedule:

Stud Size AISI/SSMA	Min. bracing spacing unless noted otherwise on structural drawings.
3-5/8 or 4 in, S-Sections ("c")	2'-6"
3-5/8 or 4 in, T-Sections ("w")	3'-0"
6 in, S-Sections ("c")	2'-6"
6 in, T-Sections ("w")	3'-0"

K. Erect studs one piece full length. Splicing of studs is not permitted, except where detailed.
   1. Where studs have been cut to receive piping conduits and equipment, weld on two 3/4 inch furring channels to restore stability of weakened stud unless noted otherwise on the drawings.

L. Erect studs, brace and reinforce full strength to meet design requirements.

M. Extend stud framing through ceiling to underside of floor or roof structure above unless detailed otherwise.

N. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.

O. Install intermediate studs above and below openings to match wall stud spacing.

P. Provide deflection allowance of 1/2 inch minimum in stud track, directly below horizontal building framing for non-load bearing framing.

Q. Attach backing as detailed on the drawings for attachment of fixtures anchored to walls.

R. Install framing between studs for attachment of mechanical and electrical items and to prevent stud rotation.

S. Touch-up field welds and damaged primed surfaces with primer.

T. Erect 2 stud construction at expansion joints, 20 feet on center or as indicated on Drawings.

3.03 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with enlarged service holes, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness.
      a. 20 GA (0.0329 inch)
      b. 18 GA (0.0428 inch)
      c. 16 GA (0.0538 inch)
      d. 14 GA (0.0677 inch)
      e. 12 GA (0.0966 inch)
   2. Flange Width: 1-5/8 inches, minimum unless noted otherwise on structural drawings.
   3. Install per drawings and conform to SSMA.

3.04 TOLERANCES

A. Maximum Variation from True Position: 1/8 inch in 10 feet.

B. Maximum Variation of any Member from Plane: 1/8 inch.

3.05 CLEANING

A. Clean substrate; remove dirt, oil, grease, construction markings, and foreign matter that could adversely affect final floor finish appearance or performance.

3.06 QAULITY CONTROL

A. Inspection of all field-welding operations shall be performed by qualified and certified Welding Inspector approved by the Structural Engineer and DSA.

B. Welding Inspector shall check materials, equipment, procedures, welds and certification of welders. Furnish the Owner with reports verified by the Inspector that welding has been performed in accordance with the Contract Documents.

END OF SECTION

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Miscellaneous metal items indicated and specified, or otherwise necessary for completion of the work. Work of this section includes, but is not limited to, the following:
   1. Ferrous and non-ferrous metalwork detailed on the drawings as a component part of other assemblies, but not specified elsewhere.
   2. Miscellaneous steel framing and supports including:
      a. Ceiling-hung toilet compartments.
      b. Operable partitions.
      c. Overhead doors.
      d. Mechanical and electrical equipment.
      e. Applications where framing and supports are not specified in other Sections.
   3. Metal ladders.
   4. Ladder safety cages.
   5. Metal ships' ladders.

B. Related Sections:
   1. Division 05 Section structural steel framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.

1.02 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.03 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Manufactured metal ladders.
   2. Ladder safety cages.
   3. Metal ships' ladders.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.05 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.06 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal fabrications, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   1. Structural Performance, General: Design metal fabrications to withstand the effects of gravity loads within limits and under conditions indicated.
   2. Seismic Performance: Provide metal fabrications capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Stainless Steel Bars and Shapes: ASTM A276/A276M, [**Type 304**] [**Type 316L**].

D. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

E. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

F. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.03 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

H. Post-Installed Anchors: Torque-controlled expansion anchors.
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.04 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Division 09 "Painting" Sections.

B. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.05 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.06 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
1. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous exterior framing and supports.

D. Prime miscellaneous framing and supports where indicated.

2.07 METAL LADDERS

A. General:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ACL Industries, Inc.
b. Alco-Lite Industrial Products.
c. Halliday Products.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

d. O'Keeffe's Inc.
e. Precision Ladders, LLC.
f. Royalite Manufacturing, Inc.
g. Thompson Fabricating, LLC.
h. Insert manufacturer's name.

2. Comply with ANSI A14.3, except for elevator pit ladders.
3. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:
1. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
2. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
3. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
4. Galvanizeexterior ladders, including brackets.

2.08 LADDER SAFETY CAGES

A. General:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. ACL Industries, Inc.
b. Alco-Lite Industrial Products.
c. Halliday Products.
d. O'Keeffe's Inc.
e. Precision Ladders, LLC.
f. Royalite Manufacturing, Inc.
g. Thompson Fabricating, LLC.
2. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless steel fasteners.
3. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
4. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:
1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch flat bars secured to each hoop.
4. Galvanize ladder safety cages, including brackets and fasteners.
5. Prime ladder safety cages, including brackets and fasteners, with coating system specified in Section 09 91 00 "Painting."

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.09 METAL SHIPS' LADDERS

A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ACL Industries, Inc.
      b. Alco-Lite Industrial Products.
      c. Halliday Products.
      d. O'Keeffe's Inc.
      e. Precision Ladders, LLC.
      f. Royalite Manufacturing, Inc.
      g. Thompson Fabricating, LLC.
   2. Treads shall be not less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height shall be not more than 9-1/2 inches.
   3. Fabricate ships' ladders, including railings from aluminum.
   4. Fabricate treads from pressure-locked aluminum bar grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
   5. Comply with applicable railing requirements in Section 05 52 13 "Pipe and Tube Railings."

2.10 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanizeexterior miscellaneous steel trim.

2.11 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   1. Shop prime with primers specified in Section 09 91 00.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.03 REPAIRS

A. Touchup Painting:
   1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds and damaged areas and repair galvanizing to comply with ASTM A 780/A 780M, in accordance with Annex A1 zinc solder or Annex A3 metallizing. Repair method in accordance with Annex A2 galvanizing repair paint not permitted.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Steel railings.
   2. Stainless steel railings.

1.02 COORDINATION

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.06 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails and Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Infill of Guards:
      a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
      b. Infill load and other loads need not be assumed to act concurrently.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
   1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.03 STEEL RAILINGS

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Tubing: ASTM A500/A500M (cold formed) or ASTM A513/A513M, Type 5.

C. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
   1. Provide galvanized finish for exterior installations and where indicated.

D. Plates, Shapes, and Bars: ASTM A36/A36M.

E. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 STAINLESS STEEL RAILINGS

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

B. Tubing: ASTM A554, Grade MT 304.

C. Pipe: ASTM A312/A312M, Grade TP 304.

D. Castings: ASTM A743/A743M, Grade CF 8 or CF 20.

E. Plate and Sheet: ASTM A240/A240M or ASTM A666, Type 304.

2.05 FASTENERS

A. Fastener Materials:
1. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
2. Stainless Steel Railing Components: Type 304 stainless steel fasteners.
3. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:
1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
3. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.06 MISCELLANEOUS MATERIALS

A. Handrail Brackets: Cast stainless steel..

B. Shop Primers: Provide primers that comply with Section 09 91 00 "Painting".

C. Intermediate Coats and Topcoats: Provide products that comply with Section 09 91 00 " Painting."

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.07 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
   1. Clearly mark units for reassembly and coordinated installation.
   2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.
   1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
   2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water.
   1. Provide weep holes where water may accumulate.
   2. Locate weep holes in inconspicuous locations.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay

I. Form changes in direction as follows:
1. As detailed.

J. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
2. Coordinate anchorage devices with supporting structure.

O. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.08 STEEL AND IRON FINISHES

A. Galvanized Railings:
1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3.

E. Shop-Painted Finish: Comply with Section 09 91 00 "Painting."
1. Color: As indicated by manufacturer's designations on drawings.

2.09 STAINLESS STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
1. Run grain with long dimension of each piece.
2. When polishing is completed, passivate and rinse surfaces.
3. Remove embedded foreign matter and leave surfaces chemically clean.

C. Stainless Steel Pipe and Tubing Finishes:
1. 180-Grit Polished Finish: Uniform, directionally textured finish.

D. Stainless Steel Sheet and Plate Finishes:
1. Directional Satin Finish: ASTM A480/A480, No. 4.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.
1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches of post.

3.04 ANCHORING POSTS

A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.

3.05 ATTACHING RAILINGS

A. Attach handrails to walls with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface.
1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.06 REPAIR

A. Touchup Painting:
1. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 00 "Painting."

3.07 CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Galvanized Surfaces: Clean field welds and damaged areas and repair galvanizing to comply with ASTM A780/A 780M, in accordance with Annex A1 zinc solder or Annex A3 metallizing. Repair method in accordance with Annex A2 galvanizing repair paint not permitted.

3.08 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Plywood backing panels.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for composite wood products, indicating compliance with emissions testing or certification.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Composite Wood Products:
      a. Formaldehyde emissions testing or certification.

2.02 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Treatment shall not promote corrosion of metal fasteners.
   2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

D. Application: Treat items indicated on Drawings, and the following:
   1. Plywood backing panels.

2.03 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.04 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

B. Nails, Brads, and Staples: ASTM F1667.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 06 16 43 - GYPSUM SHEATHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Exterior wall, parapet, and soffit gypsum sheathing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 GYPSUM SHEATHING

A. Gypsum Wall and Soffit Sheathing: Provide one of the following:
   1. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C1278/C1278M, gypsum sheathing, Type X**,** 5/8 inch thick.
      a. Product: Subject to compliance with requirements, provide the following:
         1) USG Corporation; Fiberock Aqua-Tough.
   2. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M, Type X**,** 5/8 inch thick.
      a. Product: Subject to compliance with requirements, provide one of the following:
         1) CertainTeed Corp.; GlasRoc Sheathing.
         2) Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
         3) USG Corporation; Securock Glass Mat Sheathing.

B. Gypsum Parapet Wall Sheathing: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch thick, factory primed.
   1. Products: Subject to compliance with requirements, provide the following
      a. Georgia-Pacific Corporation; Dens Deck Prime.

2.02 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. For gypsum sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.

B. Screws for Fastening Gypsum Sheathing to Wood Framing: ASTM C1002.

C. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.

C. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

D. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.02 GYPSUM SHEATHING INSTALLATION

A. Comply with ASTM C1280 and with manufacturer's written instructions.
1. Fasten gypsum sheathing to cold-formed metal framing with screws.
2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing, in compliance with ASTM C954.

C. Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Interior standing and running trim.
   2. Shop finishing of interior architectural woodwork.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing interior architectural woodwork that are concealed within other construction before interior architectural woodwork installation.

1.02 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that interior architectural woodwork can be supported and installed as indicated.

1.03 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Shop finishing materials.

B. Shop Drawings:
   1. Include the following:
      a. Dimensioned plans, elevations, and sections.
      b. Attachment details.
   2. Show large-scale details.
   3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.

C. Samples for Verification: For the following:
   1. Lumber for Transparent Finish: Not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Documentation for installation adhesives, indicating VOC content.
2. Documentation for installation adhesives, indicating compliance with emissions testing or certification.
3. Documentation for composite wood products, indicating compliance with emissions testing or certification.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Architectural Woodwork Standards, Section 2.

B. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas.

C. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.06 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of the construction period.

B. Established Dimensions: Where interior architectural woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.07 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Adhesives:
   a. VOC content limits for field applications.
2. Composite Wood Products:
   a. Formaldehyde emissions testing or certification.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 ARCHITECTURAL WOODWORK, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
   1. If discrepancies arise between the Contract Documents and the Architectural Woodwork Standards, comply with the more stringent requirement.

2.03 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

A. Architectural Woodwork Standards Grade: Premium.

B. Hardwood Lumber:
   1. Wood Species and Cut: Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.
   2. Wood Moisture Content: 5 to 10 percent.

2.04 COMPOSITE WOOD MATERIALS

A. Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
   1. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.05 MISCELLANEOUS MATERIALS

A. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.

B. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

2.06 FABRICATION

A. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.
   1. Ease edges to radius indicated for the following:
      a. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.

B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
   1. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.07 SHOP FINISHING

A. Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.

C. Transparent Finish:
   1. Architectural Woodwork Standards Grade: Premium .
   2. Finish System - 5: Varnish, Conversion.
   3. Staining: None required.
   4. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter in accordance with ASTM D523.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.

B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.02 INSTALLATION

A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.

B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.

C. Install interior architectural woodwork level, plumb, true in line, and without distortion.
   1. Shim as required with concealed shims.
   2. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.
   1. Secure with countersunk, concealed fasteners and blind nailing.
   2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with interior architectural woodwork.
   3. For shop-finished items, use filler matching finish of items being installed.

F. Standing and Running Trim:
   1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
   2. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary.
   3. Scarf running joints and stagger in adjacent and related members.
   4. Fill gaps, if any, between top of base and wall with plastic wood filler; sand smooth; and finish same as wood base if finished.
   5. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

3.03 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through WI's Certified Compliance Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
   1. Inspection entity shall prepare and submit report of inspection.

3.04 REPAIR

A. Repair damaged and defective interior architectural woodwork, where possible, to eliminate functional and visual defects and to result in interior architectural woodwork being in compliance with requirements of Architectural Woodwork Standards for the specified grade.

B. Where not possible to repair, replace defective woodwork.

C. Shop Finish: Touch up finishing work specified in this Section after installation of interior architectural woodwork.
   1. Fill nail holes with matching filler where exposed.
   2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.

3.05 CLEANING

A. Clean interior architectural woodwork on exposed and semiexposed surfaces.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad cabinets.
   2. Cabinet hardware and accessories.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.02 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For architectural cabinets.
   1. Include plans, elevations, sections, and attachment details.
   2. Show large-scale details.
   3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   4. Show locations and sizes of cutouts and holes for items installed in architectural cabinets.
   5. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
   6. Apply WI Certified Compliance Program label to Shop Drawings.

C. Samples for Verification: For the following:
   1. Lumber for Transparent Finish: Not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.
   2. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Documentation for composite wood products, indicating compliance with emissions testing or certification.
2. Environmental Product Declarations: For products that comply with environmental product declarations.
3. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

1.05 QUALITY ASSURANCE

A. Quality Standard: Unless otherwise indicated, comply with WI's North American Architectural Woodwork Standards (NAAWS) for grades indicated for construction, finishes, installation, and other requirements.
1. Where the Contract Documents contain requirements that are more stringent than the referenced quality standard, comply with requirements of the Contract Documents in addition to those of the referenced quality standard.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.07 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Composite Wood Products:
      a. Formaldehyde emissions testing or certification.

2.02 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Architectural Woodwork Standards Grade: Custom.

B. Type of Construction: As indicated on drawings.

C. Door and Drawer-Front Style: As indicated on drawings overlay.
   1. Reveal Dimension: As indicated on drawings.

D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
   1. Basis-of-Design Product: As indicated on Drawings.
      a. Sustainable Design Criteria:
         1) Environmental Product Declaration.
         2) Material Health Disclosure.

E. Laminate Cladding for Exposed Surfaces:
   1. Horizontal Surfaces: Grade HGS.
   2. Postformed Surfaces: Grade HGP.
   3. Vertical Surfaces: Grade VGS.
   4. Edges: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.

F. Materials for Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
      a. Edges of Plastic-Laminate Shelves: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
      b. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
      c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
   2. Drawer Sides and Backs: Solid-hardwood lumber.
   3. Drawer Bottoms: Hardwood plywood.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As indicated on drawings.

2.03 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Do not use plain-sawn softwood lumber with exposed, flat surfaces more than 3 inches wide.
2. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
2. Particleboard (Medium Density): ANSI A208.1, Grade M-2.
3. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.04 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 71 00 "Door Hardware."

B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch- thick metal, and as follows:
1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, nominal 170 degrees of opening, self-closing with integral sound damping.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Blum.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Haefele.
c. Grass.

D. Wire Pulls: Back mounted, solid metal, 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.

E. Adjustable Shelf Brackets: BHMA A156.9, B04071; Aluminum mortise-mount pilaster and steel support clip shelving system with 1/2 inch vertical slot adjustability.
1. Basis-of-Design Product: Knape & Vogt 255/256 Aluminum Series.
2. Finish: As selected by Architect from manufacturer's full range.
3. Installation Method: Pilaster supports mortised flush into cabinet and shelving walls.

F. Drawer Slides: BHMA A156.9, and as follows:
1. General Purpose Drawer Slides: Grade 1HD-100, side mounted; full-extension type; hold-in detent; progressive movement; zinc-plated steel ball-bearing slides.
a. Basis-of-Design Product: Accuride Model 7432.
2. File Drawer Slides: Grade 1HD-100; for drawers up to 24 inches wide.
a. Basis-of-Design Product: Accuride Model 4034.
3. File Drawer Slides: Grade 1HD-200; for drawers more 24 inches wide.
a. Basis-of-Design Product: Accuride Model 3640A.
4. Pencil Drawer Slides: Grade 1; for drawers not more than 3 inches high and 24 inches wide.
a. Basis-of-Design Product: Accuride Model 3832.

G. Door Locks: ANSI/BHMA A156.11, E07121.

H. Drawer Locks: ANSI/BHMA A156.11, E07041.

I. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

J. Grommets for Cable Passage through Countertops: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for BHMA finish number indicated.

L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.05 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.06 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated. Ease edges and corners to 1/16-inch radius unless otherwise indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
   2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.02 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with cabinet surface.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. For shop-finished items, use filler matching finish of items being installed.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
   1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
   2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3.03 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces. Touch up finishes to restore damaged or soiled areas.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 05 43 - CLADDING SUPPORT SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Metal cladding support systems.

B. Related Sections:
   1. Section 07 21 00 "Thermal Insulation" for continuous (exterior) insulation.
   2. Section 09 24 00 "Cement Plastering" for cement plaster and thin brick support system.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of support system and accessory.

B. Shop Drawings:
   1. Include installation layout for each cladding support system, each cladding type supported, and for each backup wall condition.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, tests performed by a qualified testing agency.

B. Energy Performance Test Reports: For each product and system, tests performed by a qualified testing agency.

C. Delegated-Design Submittal: For cladding support systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 COORDINATION

A. Coordinate cladding support system installation with cladding systems, continuous (exterior) insulation, air and weather barrier, flashing, trim, and other adjoining work.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cladding support systems that fail in materials or workmanship within specified warranty period.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Deterioration of metals and other materials beyond normal weathering.
2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:
   1. Wind Loads: As indicated on Drawings.
   2. Cladding Deflection Limits: For wind loads, space support elements and subframing as required to meet performance requirements indicated for cladding types being supported.

B. Seismic Performance: Cladding support systems with cladding types supported shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. Energy Performance: Cladding support system with cladding types supported shall have clear field U-factor of not more than the following, determined according to 3D thermal modeling in accordance with ASHRAE 1365-RP, or laboratory testing in accordance with ASTM C1363:
   1. Thermal Transmittance (U-factor): U-0.055 .

D. Fire Propagation Characteristics: Where required by building code for wall assemblies indicated, passes NFPA 285 testing as part of an approved assembly.

2.02 METAL CLADDING SUPPORT SYSTEMS

A. Thermally Isolated Aluminum Insulation Clip and Rail: System consisting of intermittent extruded aluminum spacer clips with plastic thermal isolators that accept continuous, adjustable vertically oriented extruded aluminum rails.
   1. Basis of Design Product: Nvelope USA; Nvelope-NV Series Clip System.
   2. Material: ASTM B 209; Aluminum alloy.
   3. Continuous Rails: Manufacturer's standard extruded aluminum rail.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
   1. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

B. Install rails, subframing, and other miscellaneous support members and anchorages according to cladding support manufacturer's written recommendations.

3.03 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align cladding units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 14 16 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Polyurethane waterproofing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show locations and extent of waterproofing.
   2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.05 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tremco Incorporated; TREMproof 250 GC.
      b. W.R. Meadows; Hydralastic 836.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 AUXILIARY MATERIALS

A. Protection Course: Manufacturer's recommended product for waterproofing membrane indicated.

B. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated acrylic latex, polyurethane, or epoxy.

C. Membrane-Reinforcing Fabric: Manufacturer's recommended polyester fabric.

D. Joint Reinforcing Strip: Manufacturer's recommended polyester fabric.

E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; and as recommended by manufacturer for substrate and joint conditions.
1. Backer Rod: Closed-cell polyethylene foam.

2.03 DRAINAGE PANELS

A. Composite Drainage Panels: Drainage panel acceptable to waterproofing manufacturer and consisting of a nonbiodegradable core of fused, entangled filaments or a three-dimensional drainage net; with a geotextile facing on both sides.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

F. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 1471.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

H. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 1471. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

I. Install sheet flashing and bond to deck and wall substrates where required according to waterproofing manufacturer's written instructions.

3.02 WATERPROOFING APPLICATION

A. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C 1471.

B. Unreinforced Waterproofing Applications:
1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 90 mils.

C. Install protection course with butted joints over waterproofing before starting subsequent construction operations.
1. Drainage panels may be used in place of a separate protection course for vertical applications when approved in writing by waterproofing manufacturer.

3.03 DRAINAGE PANEL INSTALLATION

A. Place and secure drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed drainage panels during subsequent construction.

3.04 PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 19 00 - WATER REPELLENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes penetrating water-repellent treatments for the following non-traffic, vertical and horizontal exterior surfaces:
   1. Surface-bonded brick masonry.

1.02 PERFORMANCE REQUIREMENTS

A. General Performance: Water repellents shall meet performance requirements indicated without failure due to defective manufacture, fabrication, or installation.
   1. Water Repellents: Comply with performance requirements specified, as determined by preconstruction testing on manufacturer's standard substrate assemblies representing those indicated for this Project.

B. Water Absorption: Minimum 80 percent reduction of water absorption after 24 hours in comparison of treated and untreated specimens.
   1. Clay Brick: ASTM C 67.

C. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, according to ASTM E 514.

D. Durability: Maximum 5 percent loss of water-repellent properties after 2500 hours of weathering according to ASTM G 154 in comparison to water-repellent-treated specimens before weathering.

1.03 PRECONSTRUCTION TESTING

A. Preconstruction Testing: Installed water repellents shall comply with performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard substrate assemblies by a qualified testing agency.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Preconstruction Testing Reports: For water-repellent-treated substrates.

B. Sample Warranty: For special warranty.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.06 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

B. Mockups: Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Locate each test application as directed by Architect.
   2. Size: 25 sq. ft. minimum.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 FIELD CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
   1. Concrete surfaces and mortar have cured for not less than 28 days.
   2. Building has been closed in for not less than 30 days before treating wall assemblies.
   3. Ambient temperature is above 40 deg F and below 100 deg F and will remain so for 24 hours.
   4. Substrate is not frozen and substrate-surface temperature is above 40 deg F and below 100 deg F.
   5. Rain or snow is not predicted within 24 hours.
   6. Not less than 24 hours have passed since surfaces were last wet.
   7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PENETRATING WATER REPELLENTS

A. Silane, Penetrating Water Repellent: Clear, containing 40 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 90 g/L or less of VOCs.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Basis-of-Design Product: Evonik Industries; Protectosil Aqua-Trete Concentrate.
   a. Subject to compliance with requirements, manufacturers offering comparable products that may be incorporated into the Work include, but are not limited to, the following:
      1) Master Builders Solutions.
      2) Fabrikem Manufacturing Ltd.
2. Locations: Where indicated, and as follows:
   a. Surface-bonded brick masonry

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
   1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in representative locations by method recommended by manufacturer.
   2. Inspect for previously applied treatments that may inhibit penetration or performance of water repellents.
   3. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
   4. Verify that required repairs are complete, cured, and dry before applying water repellent.

B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

3.02 PREPARATION

A. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.

B. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.

C. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.03 WATER REPELLENT APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply a heavy-saturation of water repellent, on surfaces indicated for treatment, using low-pressure spray to the point of saturation in number of coats and application rate recommended by manufacturer. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.

3.04 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application.

B. Comply with manufacturer's written cleaning instructions.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Insulation in cavities formed by framing members.
   2. Exterior continuous insulation.
   3. Miscellaneous rigid and semi-rigid board insulation applications.

B. Related Sections:
   1. Division 07 Sections: For insulation specified as part of roofing and horizontal waterproofing assemblies.
   2. Division 22 and 23 Sections: For pipe and duct insulation.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for insulation, indicating compliance with emissions testing or certification.
   2. Documentation for recycled content of fiberglass insulation, indicating postconsumer and preconsumer recycled content and cost.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.04 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Insulation:
      a. VOC emissions testing or certification.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Compliance with sustainable design criteria for material sourcing will require the following:
   1) Fiberglass Insulation: Minimum 30 percent total recycled content with minimum 30 percent post-consumer recycled content.

2.02 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide exterior wall assemblies with foam plastic insulation with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.03 INSULATION IN CAVITIES FORMED BY FRAMING MEMBERS

A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
   1. Locations: Where indicated, and as follows:
      a. Cavities formed with stud framing members.

2.04 EXTERIOR CONTINUOUS INSULATION

A. Unfaced, Semi-Rigid Mineral-Wool Board Insulation: ASTM C612, Type IVA or IVB; with maximum flame-spread and smoke-developed indexes of 0; and of the following nominal density and thermal resistivity:
   1. Nominal density of 4.5 lb/cu. ft., thermal resistivity of 4.2 deg F x h x sq. ft./Btu x in. at 75 deg F.
   2. Locations: Where indicated, and as follows:
      a. Continuous insulation between exterior cladding and sheathing.
   3. Product: Provide one of the following:
      a. Owens Corning; Thermafiber RainBarrier.
      b. Rockwool; CavityRock.

B. Fasteners:
   1. Cavity-Wall Fasteners: Corrosion-resistant fasteners recommended by insulation manufacturer for intended use consisting of 1-3/4 inch diameter plastic cap, and fastener indicated below.
      a. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
         1) Wind-Lock Corporation; ci-Lock Steel Series Selection.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.02 INSTALLATION OF EXTERIOR CONTINOUS INSULATION

A. Foam-Plastic Board Insulation: Mechanically fasten insulation boards to wall framing using a minimum 2-inch diameter solid plastic washer and self-taping corrosion-resistant steel screw and as recommended by manufacturer.
   1. Press units firmly against inside substrates.

B. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches from each corner of board insulation, at center of board, and as recommended by manufacturer.
   1. Fit courses of insulation between obstructions, with edges butted tightly in both directions, and with faces flush.
   2. Press units firmly against inside substrates.

3.03 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions and according to ASTM C1320. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For wall cavities where cavity heights exceed 96 inches, support unfaced glass fiber blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation.
   1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 24 19 - WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Water-drainage exterior insulation and finish system (EIFS).
   1. EIFS-clad drainage-wall assemblies that are field applied over substrate.
   2. Thin brick veneer.
   3. Water-resistive barrier coatings.
   4. Joint sealants.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 DEFINITIONS

A. Definitions in ASTM E2110 apply to Work of this Section.

1.03 ACTION SUBMITTALS

A. Product Data: For each EIFS component, trim, and accessory, including water-resistive barrier coatings and joint sealants, and for each type of masonry product.

B. Shop Drawings:
   1. Show locations and extent of water-resistive air barrier materials, accessories, and assemblies specific to Project conditions.
   2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of water-resistive air barrier.
   4. Include details for EIFS buildouts.
   5. Include details for parapet cap flashing.
   6. Include details for adhered masonry.

C. Samples: For each exposed product and for each color and texture specified, [8 inches square] <Insert dimension and shape> in size.

D. Samples for Initial Selection: For each type of finish-coat color and texture indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Samples for Verification: 24-inch- square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work, including custom trim, each profile, and an aesthetic reveal.
   1. Include exposed trim and accessory Samples to verify color selected.
   2. Include a typical control joint filled with sealant of color selected, as specified in Section 07 92 00 "Joint Sealants."
   3. For each masonry finish type indicated. Include at least two Samples in each set, and show the full range of color and other visual characteristics in completed Work.
   4. For each color of mortar required.

1.04 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates: Signed by EIFS manufacturer, certifying the following:
   1. EIFS complies with requirements.and installer is approved by manufacture
   2. Substrates to which EIFS is indicated to be attached are acceptable to EIFS manufacturer.
   3. Accessory products installed with EIFS, including joint sealants, flashing, water-resistive barrier coatings, trim, whether or not furnished by EIFS manufacturer and whether or not specified in this Section, are acceptable to EIFS manufacturer.

B. Product Test Reports: For each EIFS assembly and component, and for water-resistive barrier coatings, for tests performed by a qualified testing agency.

C. Sample Warranty: For manufacturer's special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For EIFS to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, to set quality standards for materials and execution, and to set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.

B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   1. Stack insulation board flat and off the ground.
   2. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.08 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.
   1. Proceed with installation of adhesives or coatings only when ambient temperatures have remained, or are forecast to remain, above 40 deg F for a minimum of 24 hours before, during, and after application. Do not apply EIFS adhesives or coatings during rainfall.

1.09 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of EIFS-clad drainage-wall assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Bond integrity and weathertightness.
      b. Deterioration of EIFS finishes and other EIFS materials beyond normal weathering.
   2. Warranty coverage includes the following components of EIFS-clad drainage-wall assemblies:
      a. EIFS finish, including base coats, finish coats, and reinforcing mesh.
      b. Insulation installed as part of EIFS.
      c. Insulation adhesive.
      d. EIFS accessories, including trim components and flashing.
      e. Water-resistive barrier coatings.
      f. EIFS drainage components.
   3. Warranty Period: 12 years from date of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Dryvit Systems, Inc.; Outsulation Masonry Veneer System (OMVS) System.
   1. Omega Products International, Inc.
   2. Parex USA, Inc.
   3. Senergy; Master Builders Solutions.
   4. Sto Corp.

B. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with EIFS components.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.

2.03 PERFORMANCE REQUIREMENTS

A. EIFS Performance: Comply with ASTM E2568 and with the following:
   1. Weathertightness: Resistant to uncontrolled water penetration from exterior, with a means to drain water entering EIFS to the exterior.
   2. System Fire Performance: Full-scale multistory fire test.
   3. Structural Performance of Assembly and Components:
      a. Wind Loads:
         1) Uniform pressure as indicated on Drawings.
   4. Drainage Efficiency: 90 percent average minimum when tested in accordance with ASTM E2273.

2.04 EIFS MATERIALS

A. Flexible-Membrane Flashing: Cold-applied, self-adhering, self-healing, rubberized-asphalt, and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.

B. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; specifically formulated to be applied to back side of insulation in a manner that creates open vertical channels designed to serve as an integral part of the water-drainage system of the EIFS-clad drainage-wall assembly; compatible with substrate; and complying with the following:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.

C. Molded, (Expanded) Rigid Cellular Polystyrene Board Insulation: Comply with ASTM E2430/E2430M, unless otherwise noted, and the following:
   1. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, in accordance with ASTM E84.
   2. Dimensions: Provide insulation boards of not more than 24 by 48 inches, with thickness indicated on Drawings.
   3. Foam Buildouts: Provide with profiles and dimensions indicated on Drawings.

D. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. in accordance with ASTM E2098/E2098M and the following:
   1. Reinforcing Mesh for EIFS, General: Not less than weight required to comply with impact-performance level specified in "Performance Requirements" Article.

E. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.

F. Water: Potable.

2.05 MASONRY VENEER - GENERAL

A. General: Masonry veneer shall comply with the following:
   1. Masonry Veneer Units shall have a minimum thickness of 1/4 inch except those parts of a unit within 0.5 inch of the unit perimeter.
   2. The average thickness of each Manufactured Stone Masonry Veneer unit shall be less than or equal to 2-5⁄8 inches.
   3. Units shall not exceed 36 inches in any face dimension and shall not exceed more than 5 feet 2 inches total face area.
   4. Shall develop a shear bond strength between the Substrate, Skim Coat Substrate Preparation, selected masonry veneer unit and the Dryvit Primus Adhesive of not less than 50 psi when tested in accordance with Test Method ASTM C482.
   5. Shall have a maximum allowable saturated weight of 15 lb/ft² for veneer and mortar combined.
   6. Maximum allowable height above grade shall comply with the Outsulation Masonry Veneer System wind load testing data and in accordance with selected masonry veneer material manufacturer.

2.06 THIN BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels.

B. Clay Thin Brick: Complying with ASTM C1088, Grade Exterior, Type TBX .
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or a comparable product by one of the following manufacturers:
   a. H.C. Muddox.
   b. Interstate Brick.
   c. Pacific Clay Products, Inc.
2. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
3. Size (Actual Dimensions): As indicated on drawings .
4. Thickness: 5/8 thick.
5. Color and Texture: As selected by Architect from manufacturer’s full range.

2.07 MORTAR

A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C207, Type S.

C. Aggregate: ASTM C144 and as follows:
1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
   a. Match Architect's sample.

D. Water: Potable.

2.08 MISCELLANEOUS MATERIALS

A. Water-Resistive Barrier Coating: Manufacturer's standard formulation and accessories for use as water-resistive barrier coating; compatible with substrate.
1. Water-Resistance: Comply with physical and performance criteria of ASTM E2570/E2570M.
2. Product: Dryvit Backstop NTX.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Skim Coat: Manufacturer's standard formulation and accessories for with adhered amsonry veneer EIFS; compatible with substrate.
   1. Product: Dryvit Modified Primus.

C. Joint Sealants: Silicone sealant, type as recommended by sealant manufacturer, and as follows:
   1. Product: Tremco; Spectrem Series.

D. Masonry Cleaner: Masonry manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

2.09 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

B. Mortar for Masonry Veneer: Comply with ASTM C270, Proportion Specification.
   1. Mortar for Pointing Thin Brick: Type N.

C. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   1. Pigments do not exceed 10 percent of portland cement by weight.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.10 MIXING

A. Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials, except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Begin coating application only after surfaces are dry.
2. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.

B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.

C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.
1. Concrete Substrates: Provide clean, dry, neutral-pH substrate for insulation installation. Verify suitability of substrate by performing bond and moisture tests recommended by EIFS manufacturer.

3.03 INSTALLATION OF EIFS, GENERAL

A. Comply with ASTM C1397, ASTM E2511, and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.04 APPLICATION OF SUBSTRATE PROTECTION

A. Water-Resistive Barrier Coating: Apply over sheathing to provide a water-resistive barrier.
   1. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.

B. Flexible-Membrane Flashing: Install over water-resistive barrier coating, applied and lapped to shed water; seal at openings, penetrations, and terminations. Prime substrates with flashing primer if required and install flashing.

3.05 INSTALLATION OF INSULATION

A. Board Insulation: Adhesively attach insulation to substrate in compliance with ASTM C1397 and the following:
   1. Apply adhesive to insulation by notched-trowel method, with notches oriented vertically to produce drainage channels that remain functional after the insulation is adhered to substrate.
   2. Press and slide insulation into place. Apply pressure over entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
   3. Allow adhered insulation to remain undisturbed for not less than 24 hours, before beginning rasping and sanding insulation or applying base coat and reinforcing mesh.
   4. Apply insulation over substrates in courses with long edges of boards oriented horizontally.
   5. Begin first course of insulation from a level base line and work upward.
   6. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
   7. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints, so no piece of insulation is less than 12 inches wide or 6 inches high. Offset joints not less than 6 inches from corners of window and door openings and not less than 4 inches from aesthetic reveals.
      a. Adhesive Attachment: Offset joints of insulation not less than 6 inches from horizontal and 4 inches from vertical joints in sheathing.
   8. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
   9. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

10. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch. Prevent airborne dispersal and immediately collect insulation raspings or sandings.
11. Interrupt insulation for expansion joints where indicated.
12. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and water-resistive barrier coating.

B. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
1. At expansion joints in substrates behind EIFS.
2. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
3. At floor lines in multilevel wood-framed construction.
4. Where wall height or building shape changes.
5. Where EIFS manufacturer requires joints in long continuous elevations.

3.06 APPLICATION OF BASE COAT

A. Base Coat: Apply full coverage to exposed insulation with not less than 1/16-inch dry-coat thickness.

B. Reinforcing Mesh: Embed reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners, overlapped not less than 2-1/2 inches or otherwise treated at joints to comply with ASTM C1397. Do not lap reinforcing mesh within 8 inches of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are invisible.

3.07 APPLICATION OF SKIM COAT

A. Apply skim coat to fully cured base coat substrate in advance of installation of the masonry veneer in strict accordance with EIFS manufacturer's instructions.
1. Allow skim coat to set for 1-2 minutes. Skim coat must be wet when adhering the veneer.

3.08 APPLICATION OF MASONRY VENEER UNITS

A. Adhesively apply masonry veneer unites in accordance with EIFS manufacturer's instructions. Apply adhesive to the backside of the veneer unit covering the backside completely, in thickness required for each type of masonry veneer unit.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.09 MASONRY VENEER POINTING

A. Prepare joint surfaces for pointing with mortar by removing dust and deleterious particles.

B. Point joints by placing and compacting pointing mortar in layers of not more than 3/8 inch (10 mm) deep. Compact each layer thoroughly, and allow to it become thumbprint hard before applying next layer.

C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
1. Joint Profile: As indicated.

3.10 INSTALLATION OF JOINT SEALANTS

A. Comply with Section 07 92 00 “Joint Sealants” and EIF system and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

3.11 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Water-resistive barrier coatings applied over sheathing.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. EIFS Tests and Inspections: In accordance with ASTM E2359/E2359M.

D. EIFS will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 25 00 - WEATHER BARRIERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Self-adhering weather barriers.

B. Related Sections:
   1. 076500 - Flexible Flashing: For flexible flashings not part of weather barrier assemblies.

1.02 DEFINITIONS

A. Weather Barrier: Material within the exterior envelope assembly that performs as a water-resistive and air barrier, primarily to mitigate the consequences of bulk water intrusion through cladding systems and air movement through assemblies.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For weather barrier assemblies.
   1. Show locations and extent of weather barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports: From manufacturer's technical personnel.

B. Sample Warranties.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by weather barrier system manufacturer to install manufacturer's product.

1.06 PRECONSTRUCTION TESTING

A. Mockup Testing: Weather barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
   1. Mockups will be tested for air-leakage rate according to ASTM E2357.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of weather barriers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General: Weather barrier shall be capable of performing as a continuous barrier to air, water, and perform as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Weather barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Weather Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E2357.

C. Self-Adhering Flexible Flashing Performance: Self-adhering flexible flashing shall meet minimum performance requirements when tested according to AAMA 711.

D. Fluid-Applied Flashing Performance: Fluid-applied flashing shall meet minimum performance requirements when tested according to AAMA 714.

2.02 SELF-ADHERING POLYPROPYLENE SHEET WEATHER BARRIERS

A. Self-Adhering, Multi-Layer, Vapor-Permeable Polypropylene Sheet: Self-adhering sheet consisting of multiple layers of spun-bonded polypropylene fabric with full surface coating of pressure sensitive adhesive with release liner on adhesive side.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dorken; Delta-Vent SA.
      b. Vaproshield; Wrapshield SA.
      c. GCP Applied Technologies; Perm-A-Barrier VPS.

B. Detailing Accessories: Self-adhering membranes, liquid flashing membranes, and sealants recommended by manufacturer for sealing joints and penetrations in weather barrier.

2.03 ACCESSORY MATERIALS

A. General: Accessory materials recommended by weather barrier manufacturer to produce a complete weather barrier assembly and compatible with weather barrier membrane.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.02 SURFACE PREPARATION

A. Mask off adjoining surfaces not covered by weather barrier to prevent spillage and overspray affecting other construction.

B. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

C. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

D. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

3.03 SELF-ADHERING WEATHER BARRIER INSTALLATION

A. General: Install modified bituminous sheets and accessory materials according to weather barrier manufacturer's written instructions.
   1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering weather barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.

B. Apply primer to substrates when required by weather barrier manufacturer in accordance with manufacturer's instructions.

C. Apply and firmly adhere sheets horizontally over area to receive weather barrier. Accurately align sheets and maintain uniform minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
   1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.
   2. Roll sheets firmly to enhance adhesion to substrate.

D. Seal top of through-wall flashings to weather barrier sheet.

E. Install weather barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air and weather barrier.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Do not cover weather barrier until it has been inspected by manufacturer's technical personnel.

G. Correct deficiencies in or remove weather barrier that does not comply with requirements; repair substrates and reapply weather barrier components.

3.04 FIELD QUALITY CONTROL

A. Inspections: Arrange for weather barrier system manufacturer's technical personnel to inspect weather barrier installation on completion.

B. Repair or remove and replace components of weather barrier system where inspections indicate that they do not comply with specified requirements.

3.05 CLEANING AND PROTECTION

A. Protect weather barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
   1. Protect weather barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace weather barrier exposed for more than days allowed by manufacturer.
   2. Protect weather barrier from contact with incompatible materials and sealants not approved by weather barrier manufacturer.

B. Remove masking materials after installation.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 26 00 - VAPOR RETARDERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Underslab vapor retarders.

B. Related Sections:
   1. Division 31 Section "Earth Moving" for drainage fill and subbase under slabs-on-grade.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.01 UNDERSLAB VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Fortifiber Building Systems Group; Moistop Ultra.
      b. Insulation Solutions, Inc.; Viper VaporCheck.
      c. Meadows, W. R., Inc.; Perminator.
      d. Raven Industries Inc.; Vapor Block.
      e. Stego Industries, LLC; Stego Wrap.

2.02 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.02 INSTALLATION OF UNDERSLAB VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.03 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 42 13.23 - METAL COMPOSITE MATERIAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Metal composite material (MCM) wall panel assemblies.

1.02 DEFINITIONS

A. D&BV: Drained and back-ventilated rainscreen system; rainscreen system designed to drain and dry cavity entering water through drainage channels, weeps, and air ventilation.

B. PER: Pressure equalized rainscreen system; rainscreen system designed for no water intrusion with equal pressure between interior system cavity and outside cladding barrier.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of MCM panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim and anchorage, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of MCM panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. MCM Panels: 12 inches long by actual panel width. Include fasteners, closures, and other MCM panel accessories. Submit custom color samples in paint manufacturer's standard size.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

D. Delegated-Design Submittal: For metal composite material wall panel assemblies, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For MCM panels to include in maintenance manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, MCM panels, and other manufactured items so as not to be damaged or deformed. Package MCM panels for protection during transportation and handling.

B. Unload, store, and erect MCM panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack MCM panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store MCM panels to ensure dryness, with positive slope for drainage of water. Do not store MCM panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on MCM panels during installation.

1.07 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of MCM panels to be performed in accordance with manufacturers' written instructions and warranty requirements.

1.08 COORDINATION

A. Coordinate MCM panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.09 WARRANTY

A. Special Warranty: Fabricator's standard form in which fabricator agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Finish manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design metal composite material wall panel assemblies.

B. Structural Performance: Provide MCM panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E330:
   1. Wind Loads: As indicated on Drawings.
   2. Deflection Limits: For wind loads, no greater than 1/180 of the perimeter framing member span and L/60 center of panel.

C. Seismic Performance: MCM panel system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Water Penetration and Ventilation: One of the following:
   1. AAMA 508 - Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding System as follows:
      a. Pressure equalized or non-pressure equalized in accordance with Annex A.
   2. AAMA 509 - Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding System as follows:
      a. Test-Pressure Difference: 6.24 lbf/sq. ft.
      b. Ventilation Through Cladding: 8 cfm/sq. ft minimum.
      c. Water on Air/Water Barrier: 3 oz/sq. ft. maximum.

E. Thermal Movements: Include expansion and contraction points as needed to allow for free and noiseless thermal movements from surface temperature changes.
   1. Temperature Change (Range): minus 20 deg F to 175 deg F, material surfaces.

F. Fire Propagation Characteristics: MCM wall assembly passes NFPA 285 testing.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 MCM WALL PANELS

A. MCM Wall Panel Systems: Provide factory-formed and -assembled wall panel system, panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.
   1. Basis-of-Design System: Subject to compliance with requirements, provide Accumet 2000 Series Preformed Composite Wall Panel system by Northern Facades; or comparable system by one of the following:
      a. Keith Panel Systems.
      b. NorthClad.
      c. Dri-Design.
      d. Sobotec.

B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- thick, coil-coated aluminum sheet facings.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide 3A Composites USA Inc.; ALUCOBOND PLUS or comparable product by one of the following:
      a. Arconic Architectural Products (USA).
      b. Mitsubishi Chemical Composites.
   2. Panel Thickness: As indicated on Drawings.
   3. Core: Fire retardant.
   4. Exterior Finish: PVDF fluoropolymer with coats and thicknesses that comply with MCM panel manufacturer's performance and warranty requirements.
      a. Color: As selected by Architect from manufacturer's full range.
   5. Peel Strength: 22.5 in-lb/in. when tested for bond integrity in accordance with ASTM D1781.Panel Thickness: 0.157 inch.
   6. Core: Fire retardant.

C. Wall Panel Attachment Components: Formed from extruded aluminum.

2.03 MISCELLANEOUS MATERIALS

A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of panels unless otherwise indicated.

B. Flashing and Trim: Provide flashing and trim formed from same material as MCM panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent panels.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Aluminum Trim: Formed with 0.040-inch thick, coil-coated aluminum sheet facings.
2. Color: Match adjacent metal composite panel.

C. Panel Sealants: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in MCM panels and remain weathertight; and as recommended in writing by MCM panel manufacturer.

2.04 FABRICATION

A. General: Fabricate and finish metal panels and metal panel systems and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.05 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Aluminum Panels and Accessories:
   1. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      a. Clear Anodized Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
      b. Color Anodized Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, MCM panel supports, and other conditions affecting performance of the Work.
   1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by MCM wall panel manufacturer.

B. Examine roughing-in for components and assemblies penetrating MCM panels to verify actual locations of penetrations relative to seam locations of MCM panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and MCM panel manufacturer's written recommendations.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.03 MCM PANEL SYSTEM INSTALLATION

A. General: Install metal composite material panel system according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor metal composite material panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Shim or otherwise plumb substrates receiving MCM panels.
   2. Flash and seal MCM panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by MCM panels are installed.
   3. Install screw fasteners in predrilled holes.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Install flashing and trim as MCM panel work proceeds.
   6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   7. Align bottoms of MCM panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by MCM panel manufacturer.

C. Attachment Assembly, General: Install attachment assembly required to support MCM wall panels and to provide a complete weathertight wall system, including extrusions, tracks, drainage channels, panel clips, and anchor channels.
   1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

D. Panel Installation: Attach MCM wall panels to supports at locations, spacings, and with fasteners recommended by Fabricator to achieve performance requirements specified.
   1. DBVR System: Install using Fabricator's standard assembly with vertical channel that provides support and secondary drainage assembly, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by Fabricator. Attach MCM wall panels by inserting horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Track-Support Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use Fabricator's standard horizontal tracks and vertical drain channels that provide support and secondary drainage assembly, draining to the exterior at horizontal joints through drain tube. Attach MCM wall panels to tracks by interlocking panel edges with Fabricator's standard "T" clips.
b. Panel Installation:
   1) Attach routed-and-returned flanges of wall panels to perimeter extrusions with manufacturer's standard fasteners.
   2) Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.

E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete MCM panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by MCM panel Fabricator; or, if not indicated, provide types recommended in writing by MCM system Fabricator.

F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, or SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.04 ERECTION TOLERANCES

A. Site Verifications of Conditions:
1. Verify conditions of substrate previously installed under other Sections are acceptable for the MCM system installation. Provide documentation indicating detrimental conditions to the MCM system performance.
2. Once conditions are verified, MCM system installation tolerances are as follows:
   a. Shim and align MCM wall panel units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.05 FIELD QUALITY CONTROL

A. Fabricator's Field Service: Engage a factory-authorized service representative to test and inspect completed MCM wall panel installation, including accessories.

B. MCM wall panels will be considered defective if they do not pass test and inspections.

C. Prepare test and inspection reports.

3.06 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as MCM panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of MCM panel installation, clean finished surfaces as recommended by MCM panel manufacturer. Maintain in a clean condition during construction.

B. After MCM panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. At Architect's direction, touch up minor scratches and abrasions in finishes in accordance with finish manufacturer's instructions.

D. Replace MCM panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 42 46.16 - FIBER CEMENT WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Fiber cement wall panels.

B. Related Sections:
   1. Section 07 05 43 - "Cladding Suport Systems" for fiber cement panel support.
   2. Section 07 60 00 "Flashing and Sheet Metal" for field-formed flashings and other sheet metal work not part of wall panel assemblies.

1.02 SYSTEM DESCRIPTION

A. Fiber Cement Wall Panel Assembly: Fiber cement wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete ventilated fiber cement wall cladding system.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings: Include fabrication and installation layouts of fiber cement wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of fiber cement panel indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of fiber cement wall panel from single source from single manufacturer.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Build mockup of typical wall panel, as shown on Drawings; including insulation, supports, attachments, and accessories. Include four-way joint.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Preinstallation Conference: Conduct conference at Project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, fiber cement wall panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.

B. Unload, store, and erect fiber cement wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack fiber cement wall panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining or other surface damage.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before fiber cement wall panel fabrication and indicate measurements on Shop Drawings.

1.08 COORDINATION

A. Coordinate fiber cement wall panel assemblies with flashing, trim, construction of studs, and other adjoining work.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fiber cement wall panel assemblies that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures, including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.
2. Warranty Period: 10 years from date of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Fiber cement wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Structural Performance: Provide fiber cement wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
   1. Wind Loads: As indicated on Drawings.
   2. Deflection Limits: For wind loads, no greater than 1/240 of the span.

C. Seismic Performance: Rainscreen cladding assembly shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.02 FIBER CEMENT WALL PANELS

A. Integral Colored Fiber Cement Wall Panels: Provide factory-formed, fiber cement wall panels fabricated from sheets formed into profile for installation method indicated. Include attachment system components and accessories required for complete system.
   1. Material: Integral colored fiber cement, silicon-calcium strengthened with a combination of polyvinyl fibers without asbestos, fiberglass or formaldehyde.
   2. Panel Size: As indicated on drawings.
   3. Panel Thicknesses: As indicated on drawings.
   4. Exterior Finish: Smooth.

B. Manufacturers:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Eternit AG Niederurnen; SwissPearl Panel.
      b. Equitone.
      c. fibreC Exterior; fiberC North America.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 MISCELLANEOUS MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

B. Fasteners: Manufacturer's standard, concealed corrosion resistant fasteners.

2.04 ACCESSORIES

A. Fiber Cement Wall Panel Accessories: Provide components required for a complete fiber cement wall panel assembly including trim, copings, fasciae, mullions, sills, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Prefinished galvanized steel or aluminum, same color as adjacent fiber cement wall panels, minimum 0.030 inch thick unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, fiber cement wall panel supports, and other conditions affecting performance of the Work.

B. Examine roughing-in for components and systems penetrating fiber cement wall panels to verify actual locations of penetrations relative to seam locations of panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous fiber cement wall panel support members and anchorage according to ASTM C 754 and panel manufacturer's written instructions.

3.03 FIBER CEMENT WALL PANEL INSTALLATION

A. General: Install fiber cement wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Commence fiber cement wall panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
   2. Shim or otherwise plumb substrates receiving fiber cement wall panels.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Install flashing and trim as fiber cement wall panel work proceeds.
4. Install with exposed fasteners.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by fiber cement wall panel manufacturer.

C. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.

D. Attachment System, General: Install attachment system required to support fiber cement wall panels, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
2. Track-Support Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard horizontal tracks and vertical tracks that provide support and secondary drainage assembly, draining to exterior at horizontal joints. Attach fiber cement wall panels to tracks with interlocking edges.

3.04 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align fiber cement wall panel units within installed tolerance of 1/4 inch in 20 feet, noncumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed fiber cement wall panel installation, including accessories.

B. Fiber cement wall panels will be considered defective if they do not pass inspections.

C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Polyvinyl-chloride roofing membrane assembly including the following:
   1. Adhered polyvinyl chloride (PVC) roofing system.
   2. Substrate board.
   3. Air barrier / vapor retarder.
   4. Roof insulation.
   5. Cover board.
   6. Walkways.
   7. Movement joints integral to membrane assembly.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
   1. Layout and thickness of insulation.
   2. Flashings and membrane termination details.
   3. Flashing details at penetrations.
   4. Tapered insulation layout, thickness, and slopes.
   5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
   6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
   7. Tie-in with adjoining air barrier.

C. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives and sealants, indicating VOC content.
   2. Documentation for adhesives and sealants, indicating compliance with emissions testing or certification.

B. Manufacturer Certificates:
   1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
      a. Submit evidence of compliance with performance requirements.
   2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Field quality-control reports.

E. Sample Warranties: For manufacturer's special warranties.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
   1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, air barrier / vapor retarder, and other components of roofing system.
   2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, air barriers / vapor retarders, and walkway products, for the following warranty period:
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.
   2. Sealants:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.02 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
1. Zone 1 (Roof Area Field): 45 lbf/sq. ft.
2. Zone 2 (Roof Area Perimeter): 66 lbf/sq. ft.
a. Location: From roof edge to 0.6h inside roof edge.
3. Zone 3 (Roof Area Corners): 90 lbf/sq. ft.
a. Location: 0.2h deep by 0.6h long in each direction from building corner.

D. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and shall be listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.
1. Wind Uplift Load Capacity: 90 psf.

E. Energy Performance: Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.

F. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.03 POLYVINYL CHLORIDE (PVC) ROOFING

A. PVC Sheet: ASTM D4434/D4434M, Type II, glass-fiber reinforced, felt backed.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Sika Sarnafil G410 Feltback or comparable product by one of the following:
a. Carlisle.
b. Firestone.
2. Thickness: 60 mils.
3. Exposed Face Color: White .
a. Fibertite.

B. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
   1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced PVC sheet flashing, 55 mils thick, minimum, of same color as PVC sheet.

C. PVC-Coated Metal Sheet Flashing: Manufacturer's standard PVC-coated, heat-weldable sheet metal flashing, 0.0239-inch thick minimum, with 20 mils thick PVC coating of same color as PVC sheet laminated to one side.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.

D. Flanged Roof Expansion Joint: Manufactured, continuous, waterproof, dual-seal, double-flanged expansion joint assembly, consisting of exposed, extruded PVC membrane secured along each edge to a flange for nailing to substrate. Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

   1. Product: Subject to compliance with requirements, provide the following:
      a. Sika; Emseal Roofjoint.

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

   2. Design Criteria:
      a. Joint Width: As indicated on Drawings .

If retaining "Minimum Joint Width" and "Maximum Joint Width" subparagraphs above, delete "Movement Capability" Subparagraph below. "-25 percent/+75 percent" option is an example only; if retaining, revise as required. See Evaluations for explanation of movement capability.

      b. Movement Capability: As indicated on Drawings.
      c. Type of Movement: Seismic.

E. Liquid-Applied Flashing: Manufacturer's standard reinforced flashing, 80 mils thick, minimum.

F. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

G. Bonding Adhesive: Manufacturer's standard.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

H. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

J. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.05 SUBSTRATE BOARDS

A. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M, fiber-reinforced gypsum board, as recommended by roofing membrane manufacturer.
1. Thickness: Type X, 5/8 inchthick.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.06 AIR BARRIER / VAPOR RETARDER

A. Sheet Air Barrier / Vapor Retarder: Manufacturer's recommended SBS-modified bitumen sheet product, minimum 30-mil-total thickness; self-adhering, cold adhesive applied, or torch applied, with slip-resisting surface compatible with adhered insulation and release paper backing. Provide primer when recommended by manufacturer.
1. Mastic: Type recommended by manufacturer for sealing penetrations and terminations in air barrier / vapor retarder.

2.07 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by PVC roof membrane manufacturer.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
1. Compressive Strength: 20 psi, minimum.

C. Tapered Insulation: Provide factory-tapered insulation boards.
1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch.
3. Slope:
a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.08 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.

D. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
1. Thickness: 1/4 inch.

2.09 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
1. Size: Approximately36 by 60 inches.
2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section steel decking.
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.
   a. Test Frequency: One test probe per each 1000 sq. ft., or portion thereof, of roof deck, with not less than three tests probes.
   b. Submit test reports within 24 hours after performing tests.
6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.03 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

C. Coordinate installation and transition of roofing system component serving as an air barrier with adjacent air barrier material and assemblies

3.04 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
   1. At steel roof decks, install substrate board at right angle to flutes of deck.
      a. Locate end joints over crests of steel roof deck.
   2. Tightly butt substrate boards together.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.
6. Loosely lay substrate board over roof deck.

3.05 INSTALLATION OF AIR BARRIER / VAPOR RETARDER

A. Self-Adhering-Sheet: Prime substrate if required by manufacturer. Install sheet over area to receive air barrier / vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Seal laps by rolling.
3. Tie to adjacent air barrier materials and assemblies.

B. Completely seal air barrier / vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:
1. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows.
a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

e. Fill gaps exceeding 1/4 inch with insulation.
f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.
e. Fill gaps exceeding 1/4 inch with insulation.
f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
1) Set each layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

D. Installation Over Concrete Decks:
1. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows.
a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.
e. Fill gaps exceeding 1/4 inch with insulation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Adhere base layer of insulation to vapor retarder according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
1) Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft., and allow primer to dry.
2) Set insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.
e. Fill gaps exceeding 1/4 inch with insulation.
f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
1) Set each layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

3.07 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
a. Trim cover board so that water flow is unrestricted.
3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Set cover board in insulation adhesive, firmly pressing and maintaining insulation in place.

3.08 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

F. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.

G. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

H. Apply roof membrane with side laps shingled with slope of roof deck where possible.

I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
   2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.09 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.10 INSTALLATION OF MOVEMENT JOINTS

A. Comply with manufacturer's written instructions for handling and installing roof expansion joints.
   1. Anchor roof expansion joints securely in place, with provisions for required movement.
   2. Provide uniform, neat seams.
   3. Install roof expansion joints to fit substrates and to result in watertight performance.

3.11 INSTALLATION OF WALKWAYS

A. Flexible Walkways:
   1. Install flexible walkways at the following locations:
      a. Retain one or more subparagraphs below. Revise to suit Project.
      b. Perimeter of each rooftop unit.
      c. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
      d. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
      e. Top and bottom of each roof access ladder.
      f. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
      g. Locations indicated on Drawings.
      h. As required by roof membrane manufacturer's warranty requirements.
   2. Provide 6-inch clearance between adjoining pads.
   3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.12 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.13 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 60 00 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Manufactured Products:
      a. Manufactured reglets and counterflashing.
   2. Formed Products:
      a. Formed sheet metal fabrications.

B. Related Sections:
   1. Section 07 54 19 "Polyvinyl-Chloride (PVC) Roofing for PVC-coated sheet metal flashing integral to roofing membrane system.
   2. Section 07 71 00 "Roof Specialties" for manufactured roof sheet metal coping and roof edge fabrications.
   3. Section 07 65 00 "Flexible Flashing" for flexible flashing membranes.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation layouts of flashing and sheet metal, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
   1. Include details for forming, joining, supporting, and securing flashing and sheet metal, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.
   2. Include identification of material, thickness, weight, and finish for each item.

C. Samples: For each exposed product and for each finish specified.

1.03 INFORMATIONAL SUBMITTALS

A. Maintenance data.

1.04 QUALITY ASSURANCE

A. Flashing and Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed; 2B (bright, cold rolled) finish.

C. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
   2. Exposed Finish: Fluoropolymer, unless indicated otherwise.
      a. Color: As indicated by manufacturer's designations.
   3. Factory-Applied Pretreatment: Where painting after installation is indicated, prepare and pretreat to comply with coating manufacturers' written instructions.

2.02 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete flashing and sheet metal installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
      b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
   3. Fasteners for Metallic-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

C. Solder:
   1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
   2. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in flashing and sheet metal and remain watertight.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.03 REGLETS

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cheney Flashing Company.
      b. Fry Reglet Corporation.
      c. Heckmann Building Products Inc.
      d. Hickman, W. P. Company.
      e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
      f. Keystone Flashing Company, Inc.
      g. National Sheet Metal Systems, Inc.
      h. Sandell Manufacturing Company, Inc.
   2. Material: Stainless steel, 0.019 inch thick.
   3. Finish: Mill.

2.04 FABRICATION, GENERAL

A. General: Custom fabricate flashing and sheet metal to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
   1. Obtain field measurements for accurate fit before shop fabrication.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Form flashing and sheet metal without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.

C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Stainless Steel and Galvanized Sheet Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

F. Prefinished Sheet Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

2.05 SHEET METAL FABRICATIONS

A. Built-in Gutters: Fabricate to cross section indicated, with soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch- long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
1. Fabricate from the following materials:
a. Stainless Steel: 0.016 inch thick.

B. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes built-in overflows. Fabricate from one of the following materials:
1. Galvanized Steel: 0.028 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

C. Counterflashing: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch thick.

D. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from one of the following materials:
1. Galvanized Steel: 0.022 inch thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. General: Anchor flashing and sheet metal and other components of the Work securely in place, with provisions for thermal and structural movement so that completed flashing and sheet metal shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete flashing and sheet metal system.
   1. Install flashing and sheet metal true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
   2. Install flashing and sheet metal to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
   4. Install exposed flashing and sheet metal without excessive oil canning, buckling, and tool marks.
   5. Install sealant tape where indicated.
   6. Torch cutting of flashing and sheet metal is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
   1. Coat back side of stainless-steel flashing and sheet metal with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Seal joints as shown and as required for watertight construction.

E. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
   1. Do not solder metallic-coated steel and aluminum sheet.
   2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

3.02 SHEET METAL FLASHING INSTALLATION

A. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch below scupper discharge.

B. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant.

3.03 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as flashing and sheet metal are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 65 00 - FLEXIBLE FLASHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Self-adhering flexible flashing.
   2. Extruded-silicone sheet flexible flashing.
   3. Liquid-applied flexible flashing.

B. Related Sections:
   1. Section 07 25 00 "Weather Barriers" for flexible flashings integral to weather barrier assemblies.
   2. Section 07 60 00 "Flashing and Sheet Metal" for sheet metal flashing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation layouts of flashing, including plans, elevations, expansion-joint locations, and keyed details.
   1. Include details for forming, joining, supporting, and securing flashing, including termination points, expansion joints, edge conditions, special conditions, and connections to adjoining work.
   2. Include identification of material and thickness for each item.

C. Samples: For each exposed product and for each finish specified.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of flexible flashing product, for tests performed by a qualified testing agency.

B. Maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Flexible Flashing Performance, General: Flexible flashing seals with adjacent construction shall be capable of performing as a continuous air and water barrier. Flexible flashing shall be capable of accommodating substrate movement, construction material changes, penetrations, and transitions without deterioration, water penetration under pressure differential, and air leakage exceeding specified limits.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Self-Adhering Flexible Flashing Performance: Self-adhering flexible flashing shall meet minimum performance requirements when tested according to AAMA 711.

2.02 SELF-ADHERING FLEXIBLE FLASHING

A. Self-Adhering Flexible Flashing: Cold-applied flashing tape, a minimum of 30 mils thick, consisting of a polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, in factory cut widths.
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. GCP Applied Technologies; Perm-A-Barrier Wall Flashing.
      b. Henry; Blueskin TWF.
      c. W.R. Meadows; Air-Shield Thru-Wall Flashing.
   2. Locations: Transition flashing at sheathing, metal flashings, and other locations indicated.

B. High Temperature Self-Adhering Membrane Flashing: Cold-applied flashing tape, a minimum of 30 mils thick, consisting of a polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, in factory cut widths.
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Protecto Wrap: Sill Pan Flash Butyl.
      b. Henry; FortiFlash Butyl Waterproof Flashing Membrane.
   2. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
   3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.
   4. Locations:
      a. Beneath metal copings.
      b. Other locations indicated.

C. Foil-Faced Self-Adhering Membrane Flashing: Cold-applied flashing tape, a minimum of 30 mils thick, consisting of a glass scrim reinforced aluminum foil laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, in factory cut widths.
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Henry; Metal Clad.
      b. Polyguard; Aluma-Flash.
      c. W.R. Meadows; Air-Shield Aluminum Flashing.
      d. Karnak; 550 Patch-N-Go.
      e. Soprema; Soprasolin HD.
      f. GCP
   2. Locations:
      a. Glazed framing assemblies.
      b. Wall penetrations and wall openings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

c. Other locations indicated.

D. Liquid Mastic: Liquid mastic recommended by flashing manufacturer.

2.03 EXTRUDED-SILICONE SHEET FLEXIBLE FLASHING

A. Extruded-Silicone Sheet Flashing: Manufacturer's standard seal consisting of precured low-modulus silicone extrusion, with manufacturer's recommended neutral-curing silicone sealant for bonding extrusions to substrates.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Dow Corning Corporation.
b. GE Construction Sealants; Momentive Performance Materials Inc.
2. Sheet Flashing Width: Joint size indicated on Drawings.
3. Sheet Flashing Color: As selected by Architect from full range of industry colors.
4. Locations:
a. Glazed framing assemblies.
b. Other locations indicated.

2.04 LIQUID-APPLIED FLEXIBLE FLASHING

A. Multicomponent, Reinforced, Polymethyl Methacrylate (PMMA) Flashing:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Kemper System Kemperol AC Speed FR or comparable product by one of the following:
a. Soprema.
b. Siplast.
2. Membrane-Reinforcing Fabric: Manufacturer's recommended polyester fabric reinforcement.
3. Thickness: 90 mils, minimum.
4. Primer: As recommended by manufacturer for substrates indicated.
5. Finish Coat: Manufacturer's standard finish coat of type required and recommended for application over PMMA flashing membrane.
a. Color: As selected by Architect from manufacturer's full range.
6. Locations:
a. Door sills.
b. Rough openings.
c. Transitions at waterproofing membranes.
d. Other locations indicated.

2.05 MISCELLANEOUS MATERIALS

A. General: Provide materials required for complete flashing installation as recommended by manufacturer.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. General: Install flashing securely in place, with provisions for thermal and structural movement so that completed flashing shall not leak and shall remain watertight.
   1. Install flashing and sheet metal true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
   2. Install flashing to fit substrates and conform to geometry of area receiving flashing resulting in watertight performance.

3.02 SELF-ADHERING FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.
   1. Clean, prepare, prime, and treat substrates according to manufacturer's written instructions.
   2. Lap seams and junctures with other materials at least 4 inches except that at flashing flanges of other construction, laps need not exceed flange width.
   3. Apply in a shingled manner to shed water without interception by any exposed sheet edges.
   4. Roll firmly to enhance adhesion to substrates.

3.03 EXTRUDED-SILICONE SHEET FLEXIBLE FLASHING INSTALLATION

A. Apply extruded-silicone sheet flashing where indicated to comply with manufacturer's written instructions.
   1. Apply silicone sealant to each side of joint to produce a bead of size complying with flashing system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
   2. Press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact with substrate.
   3. Complete installation of seal system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

3.04 LIQUID-APPLIED FLEXIBLE FLASHING INSTALLATION

A. Apply flashing where indicated to comply with manufacturer's written instructions.
   1. Clean, prepare, prime, and treat substrates according to manufacturer's written instructions.
   2. Mix materials and apply flashing by roller, notched squeegee, trowel, or other suitable application method.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Apply first coat of liquid-applied flashing, embed membrane-reinforcing fabric, and apply second coat of liquid-applied flashing to completely saturate reinforcing fabric and to obtain a seamless reinforced flashing membrane free of entrapped gases and pinholes, with an average dry film total thickness of 90 mils.
4. Lap seams and junctures with other materials at least 4 inches except that at flashing flanges of other construction, laps need not exceed flange width.
5. Apply masking tape to each side of joint, outside of area to be covered by flashing system.

3.05 CLEANING AND PROTECTION

A. Protect flexible flashings from damage during application and remainder of construction period, according to manufacturer's written instructions.
   1. Protect flexible flashings from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace flexible flashing materials according to manufacturer's written instructions.
   2. Protect flexible flashings from contact with incompatible materials and sealants not approved by manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

C. Remove masking materials after installation.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Manufactured units for the following applications:
   1. Copings.
   2. Roof-edge specialties.

B. Related Sections:
   1. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom- and site-fabricated, sheet metal flashing and trim, reglets and counterflashings.
   2. Section 07 92 00 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
   3. Division 07 Sections: For flexible flashings and underlayment.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of roof specialty.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.
   1. Plans, expansion-joint locations, keyed details, and attachments to other work. Distinguish between factory pre manufactured- and field-assembled installation.
   2. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
   3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
   4. Details of termination points and assemblies, including fixed points.
   5. Details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of roof specialty copings that is ANSI/SPRI/FM 4435/ES-1 tested.

B. Design Data: For roof specialties assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Sample warranties.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roof specialties.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.06 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.07 COORDINATION

A. Coordinate roof specialties with roofing system, exterior wall system, air barrier, flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, weathertight, secure, and noncorrosive installation.
   1. Performance Coordination: Coordinate with the Work of roofing and exterior wall Sections to ensure that roof specialties provided under the Work of this Section meet or exceed specified roofing and exterior wall design performance requirements.

B. Confirm and coordinate compatibility of materials and comply with warranty requirements of roofing system manufacturer.

C. Coordinate roof specialties layout and seams with sizes and locations of joints and seams in adjacent materials.

1.08 WARRANTY

A. Special Warranty on Factory-Applied Finishes: Manufacturer agrees to repair finishes or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. SPRI Wind Design Standard: Manufacture and install copings and roof-edge specialties tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressures:
1. Design Pressure: As indicated on Drawings.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COPINGS

A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 ft., concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Metal Era; Perma-Tite Cantilever Coping or comparable product by one of the following:
a. Hickman; an MTL Company.
2. Metallic-Coated Steel Coping Caps: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal thickness as required to meet performance requirements.
a. Surface: Smooth, flat finish.
b. Finish: Two-coat fluoropolymer.
c. Color: As selected by Architect from manufacturer's full range.
3. Corners: Factory mitered and soldered or mechanically clinched and sealed watertight.
4. Coping-Cap Attachment Method: Snap-on or face leg hooked to continuous cleat with back leg fastener exposed, fabricated from coping-cap material.
a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.
b. Face-Leg Cleats: Concealed, continuous galvanized-steel sheet.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 ROOF-EDGE SPECIALTIES

A. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 ft., with a horizontal flange and vertical leg fascia terminating in a drip edge, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Metal Era; One Drip Edge PVC Coated or comparable product by one of the following:
      a. Hickman.
   2. Metallic-Coated Steel Gravel Stops: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, nominal thickness as required to meet performance requirements.
      a. Surface: Smooth, flat finish.
      b. Finish: PVC-coated.
      c. Color: As selected by Architect from manufacturer's full range.
   3. Corners: Factory mitered and soldered or mechanically clinched and sealed watertight.

2.04 SHEET METAL MATERIALS

A. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with minimum ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 coating designation; structural quality..
   1. PVC Coating: Manufacturer's standard PVC-coated flashing compatible with roofing membranel.

2.05 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Roof specialty manufacturer's recommended fasteners, designed to meet performance requirements, suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   1. Fasteners for Metallic-Coated Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install roof specialties in accordance with manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.
   1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
   2. Provide uniform, neat seams with minimum exposure of solder and sealant.
   3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
   4. Torch cutting of roof specialties is not permitted.
   5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer's written installation instructions.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
   1. Space movement joints at a maximum of 12 ft. with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Seal concealed joints with butyl sealant as required by roof specialty manufacturer.

E. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.03 INSTALLATION OF COPINGS

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.04 INSTALLATION OF ROOF-EDGE SPECIALTIES

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.05 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

B. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 71 29 - MANUFACTURED ROOF EXPANSION JOINTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aluminum roof expansion joints.

1.02 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For roof expansion joints.

C. Samples: For each exposed product and for each color specified.

D. Sample Warranties: For special warranty.

1.03 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 ALUMINUM ROOF EXPANSION JOINTS

A. Aluminum Roof Expansion Joint: Manufactured, continuous, waterproof, joint-cover assembly; consisting of a formed or extruded metal cover secured to extruded aluminum frames, with water-resistant gasketing between cover and frames, and with provision for securing assembly to substrate and sealing assembly to roofing membrane or flashing. Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Balco, Inc.
      b. C/S Group.
      c. MM Systems Corporation.
      d. Nystrom Building Products.
      e. Watson Bowman Acme Corp.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Frame Members: Extruded aluminum configured as indicated; with exposed finish matching cover.
3. Cover: Formed or extruded aluminum.
   a. Aluminum Finish: Mill.
4. Secondary Seal: Continuous, waterproof membrane within joint and attached to substrate on sides of joint below the cover.
   a. Thermal Insulation: Fill space above secondary seal with mineral-fiber blanket insulation; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84.

2.02 MATERIALS

A. Aluminum: ASTM B 209 for sheet and plate, ASTM B 221 for extrusions; alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious or preservative-treated wood materials.
   2. Mill Finish: As manufactured.

B. EPDM Membrane: ASTM D 4637, Type standard with manufacturer for application.

C. Neoprene Membrane: Neoprene sheet recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil; and as standard with roof-expansion-joint manufacturer for application.

D. PVC Membrane: ASTM D 4434, Type standard with manufacturer for application.

E. Adhesives: As recommended by roof-expansion-joint manufacturer.

F. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
   1. Exposed Fasteners: Gasketed. Use screws with hex washer heads matching color of material being fastened.

G. Mineral-Fiber Blanket: ASTM C 665.

H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with manufacturer's written instructions for handling and installing roof expansion joints.
   1. Anchor roof expansion joints securely in place, with provisions for required movement.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Install roof expansion joints true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
3. Provide for linear thermal expansion of roof expansion joint materials.
4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
5. Provide uniform, neat seams.
6. Install roof expansion joints to fit substrates and to result in watertight performance.
7. Torch cutting of roof expansion joints is not permitted.

B. Directional Changes and Other Expansion-Control Joint Systems: Install factory-fabricated units at directional changes and at transitions between roof expansion joints and exterior expansion-control joint systems specified in Division 07 Section "Expansion Control" to provide continuous, uninterrupted, and watertight joints.

C. Splices: Splice roof expansion joints with materials provided by roof-expansion-joint manufacturer for this purpose.
1. Install waterproof splices and prefabricated end dams to prevent leakage of secondary-seal membrane.

D. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Accessories installed on roofing assemblies other than mechanical or structural itemsincluding the following:
   1. Roof hatches.
   2. Heat and smoke vents.

1.02 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.
   1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Wind-Restraint Performance: As indicated on Drawings.

2.02 ROOF HATCHES

A. Roof Hatches: Metal roof-hatch units with lids and insulated [single] [double]-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing,[straight sides,] [integral metal cant,] [stepped integral metal cant raised the thickness of roof insulation,] and integrally formed deck-mounting flange at perimeter bottom.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide BILCO; Type S-90 or comparable product by one of the following:
      a. Babcock-Davis.
      b. Milcor; a division of Hart & Cooley, Inc.
      c. Nystrom.
      d. O'Keeffe's Inc.
      e. Williams Bros. Corporation of America (The).

B. Type and Size: Single-leaf lid, 30 by 30 inches .

C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.

D. Hatch Material: Stainless steel sheet.
   1. Thickness: Manufacturer's standard thickness for hatch size indicated.
   2. Finish: Manufacturer's standard.

E. Construction:
   1. Insulation: 1-inch- thick, glass-fiber board.
   2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.

F. Hardware: Spring operators, hold-open arm, stainless steel spring latch with turn handles, stainless steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
   1. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
   2. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
   3. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
   4. Fabricate joints exposed to weather to be watertight.
   5. Fasteners: Manufacturer's standard, finished to match railing system.
   6. Finish: Manufacturer's standard.
      a. Color: As selected by Architect from manufacturer's full range.

H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
   1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
   2. Height: 42 inches above finished roof deck.
   3. Material: Steel tube.
   4. Finish: Manufacturer's standard baked enamel or powder coat.
      a. Color: As selected by Architect from manufacturer's full range.

2.03 HEAT AND SMOKE VENTS

A. Hatch-Type Heat and Smoke Vents: Manufacturer's standard, with- insulated curbs, welded or mechanically fastened and sealed corner joints, integral condensation gutter, and cap flashing. Fabricate with insulated double-walled lid and continuous weathertight perimeter lid gaskets, and equip with automatic self-lifting mechanisms and UL-listed fusible links rated at 165 deg F.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco; ACDSV-Automatic Smoke Ventor comparable product by one of the following:
      a. Babcock-Davis.
      b. Milcor; a division of Hart & Cooley, Inc.
      c. Nystrom.
      d. O'Keeffe's Inc.
   2. Type and Size: double-leaf lid, size as indicated on Drawings.
   3. Loads: Minimum 40-lbf/sq. ft. external live load and 30-lbf/sq. ft. internal uplift load.
      a. When release is actuated, lid shall open against 10-lbf/sq. ft. snow or wind load and lock in position.
   4. Acoustic Performance: STC 50 and OITC 46.
   5. Heat and Smoke Vent Standard: Provide units that have been tested and listed to comply with UL 793.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

6. Curb, Framing, and Lid Material: Zinc-coated (galvanized) steel sheet.
   a. Thickness: Manufacturer's standard thickness for hatch size indicated.
   b. Finish: Factory prime coating.
7. Curb, Framing, and Lid Material: Aluminum sheet.
   a. Thickness: Manufacturer's standard thickness for hatch size indicated.
   b. Finish: Factory prime coating .
8. Construction:
   a. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
   b. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   c. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
9. Hardware: Manufacturer's standard corrosion resistant; with hinges, hold-open devices, and independent manual-release devices for operation of lids.

2.04 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

2.05 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.

C. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

D. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

F. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.
1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Roof Curb Installation: Install each roof curb so top surface is level.

C. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

D. Heat and Smoke Vent Installation:
1. Install heat and smoke vent so top perimeter surfaces are level.
2. Install and test heat and smoke vents and their components for proper operation according to NFPA 204.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.03 REPAIR AND CLEANING

A. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 00 "Painting."

B. Clean exposed surfaces according to manufacturer's written instructions.

C. Clean off excess sealants.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sealant and backing materials.
   2. Acoustical sealants.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for sealants, indicating VOC content.
   2. Documentation for sealants, indicating compliance with emissions testing or certification.

B. Product Test Reports: For each kind of joint sealant.

C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

D. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Sample Warranties: For special warranties.

1.04 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.

1.05 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.06 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period:
a. Silicone Sealants: 20 years from date of Substantial Completion.
b. All Other Sealants: Five years from date of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Sealants:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.02 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.03 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Nonstaining Joint Sealants: Where sealants are indicated to be nonstaining, provide products that exhibit no staining of substrates when tested according to ASTM C1248.

C. Mildew-Resistant Joint Sealants: Where sealants are indicated to be mildew-resistant, provide products formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

D. Colors of Exposed Joint Sealants: Custom colors, as directed by Architect.

2.04 JOINT SEALANTS

A. Silicone: Single-component, nonsag, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
   1. Joint Locations: Exterior joints in vertical surfaces and horizontal nontraffic surfaces, and as follows:
      a. Control and expansion joints in unit masonry.
      b. Joints between metal panels.
      c. Joints between different materials listed above.
      d. Perimeter joints between materials listed above and frames of doors,windows, glazed framing systems, and louvers.
      e. Control and expansion joints in ceilings and other overhead surfaces.
      f. Other joints as indicated on Drawings.
   2. Basis-of-Design Product: The Dow Chemical Company; DowSil 790, 791, or 795 at Contractor's option.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Subject to compliance with requirements, manufacturers offering comparable products that may be incorporated into the Work include, but are not limited to, the following:
   1) GE Construction Sealants; Momentive Performance Materials Inc.
   2) Pecora Corporation.
   3) Sika Corporation; Joint Sealants.
   4) Tremco Incorporated.

B. Silicone: Single-component, nonsag, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Joint Locations: Sealant joints in contact with weather barrier, weather barrier flashing materials, and as follows:
      a. Perimeter joints between materials listed above and frames of doors,windows, glazed framing systems, and louvers.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. The Dow Chemical Company; DowSil 758 Silicone Weather Barrier Sealant.
      b. Pecora Corporation; AVB Silicone.

C. Silicone: Mildew-resistant, single-component, nonsag, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Joint Locations: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces, and as follows:
      a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      b. Tile control and expansion joints in wet locations.
      c. Other joints as indicated on Drawings.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
      b. The Dow Chemical Company; DowSil 786.

D. Urethane: Multicomponent, nonsag, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.
   1. Joint Locations: Interior joints in horizontal traffic surfaces, and as follows:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Control and expansion joints in tile flooring.
      c. Other joints as indicated on Drawings.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. BASF Corporation; MasterSeal NP 2.
      b. LymTal International Inc; Iso-Flex 881 or Iso-Flex 885 SG.
      c. Pecora Corporation; Dynatred.
      d. Sika Corporation; Joint Sealants; Sikaflex 2c NS TG.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Urethane: Single-component, nonsag, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Joint Locations: Interior joints in vertical surfaces and horizontal nontraffic surfaces, and as follows:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Tile control and expansion joints.
      c. Vertical joints on exposed surfaces of unit masonry walls.
      d. Other joints as indicated on Drawings.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. Pecora Corporation; Dynatrol I-XL.
      b. Polymeric Systems, Inc; Flexiprene 1000.
      c. Sika Corporation; Joint Sealants; Sikaflex Textured Sealant.
      d. Tremco Incorporated; Dymonic.

F. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
   1. Joint Locations: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement, and as follows:
      a. Control joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and glazed framing systems.
      c. Other joints as indicated on Drawings.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. BASF Corporation; MasterSeal NP 520.
      b. Bostik, Inc.; Bosti-Flex Plus.
      c. Pecora Corporation; AC-20.
      d. Tremco Incorporated; Tremflex 834.

G. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 in accordance with ASTM D2240.
   1. Joint Locations: Interior, exposed sawcuts and non-moving control joints in concrete slabs.
   2. Color: As selected by Architect from manufacturer's full range.
   3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. BASF Corporation; MasterSeal CR 190.
      b. Sika Corporation; Joint Sealants; Sikadur 51.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.05 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834. Sealant effectively reduces airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E90.
   1. Joint Location:
      a. Acoustical joints where indicated.
      b. Other joints as indicated.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. Accumetric LLC; BOSS 826 Acoustical Sound Sealant.
      b. GE Construction Sealants; Momentive Performance Materials Inc.; RCS20 Acoustical.
      c. Grabber Construction Products; Acoustical Sealant GSC.
      d. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
      e. Pecora Corporation; AC-20 FTR.
      f. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
      g. Tremco Incorporated; Tremflex 834.

2.06 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), unless otherwise recommended by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.07 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Mineral Wool Forming Material: Unfaced mineral wool board insulation preformed or cut to fit metal deck flutes.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove laitance and form-release agents from concrete.
   2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

G. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters including heads of walls, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

3.03 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
      b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
   2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.04 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 07 95 00 - EXPANSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Interior expansion control systems.
   2. Exterior expansion control systems.

B. Related Sections:
   1. 07 7129 - Manufactured Roof Expansion Joints: For factory-fabricated roof expansion control.

1.02 SUBMITTALS

A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams and a tabular schedule of expansion control systems.

B. Samples: For each exposed expansion control system and for each color and texture specified.

C. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
   1. Manufacturer and model number for each expansion control system.
   2. Expansion control system location cross-referenced to Drawings.
   3. Nominal joint width.
   4. Movement capability.
   5. Classification as thermal or seismic.
   6. Materials, colors, and finishes.
   7. Product options.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
   1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
   2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Coordination: Coordinate installation of exterior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified in Division 07 Sections.

2.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion control systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2.03 INTERIOR EXPANSION CONTROL SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following:
   1. Architectural Art Mfg., Inc.; Division of Pittcon Industries.
   2. Balco, Inc.
   3. Construction Specialties, Inc.
   4. JointMaster/InPro Corporation.
   5. Michael Rizza Company, LLC.
   6. MM Systems Corporation.
   7. Nystrom, Inc.
   8. Watson Bowman Acme Corp.; a BASF Construction Chemicals business.

B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

C. Floor-to-Floor:
   1. Basis-of-Design Product: Indicated on Drawings.
   2. Design Criteria:
      a. Nominal Joint Width: As indicated on Drawings .
      b. Movement Capability: As indicated on Drawings.
      c. Type of Movement: Seismic.

D. Wall-to-Wall:
   1. Basis-of-Design Product: Indicated on Drawings.
   2. Design Criteria:
      a. Nominal Joint Width: As indicated on Drawings .
      b. Movement Capability: As indicated on Drawings.
      c. Type of Movement: Seismic.
   3. Type: As indicated on drawings.

E. Wall-to-Ceiling:
   1. Basis-of-Design Product: Indicated on Drawings.
   2. Design Criteria:
      a. Nominal Joint Width: As indicated on Drawings .

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Movement Capability: As indicated on Drawings.
c. Type of Movement: Seismic.

F. Ceiling-to-Ceiling:
1. Basis-of-Design Product: Indicated on Drawings.
2. Design Criteria:
a. Nominal Joint Width: As indicated on Drawings .
b. Movement Capability: As indicated on Drawings.
c. Type of Movement: Seismic.

2.04 EXTERIOR EXPANSION CONTROL SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following:
1. Balco, Inc.
2. Construction Specialties, Inc.
3. EMSEAL Corporation.
4. MM Systems Corporation.
5. Watson Bowman Acme Corp.; a BASF Construction Chemicals business.

B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.

C. Wall-to-Wall:
1. Basis-of-Design Products: Indicated on Drawings.
2. Design Criteria:
a. Nominal Joint Width: As indicated on Drawings .
b. Minimum Joint Width: As indicated on Drawings .
c. Maximum Joint Width: As indicated on Drawings .
d. Movement Capability: As indicated on Drawings.
e. Type of Movement: Seismic.
3. Type: Flat seal.
a. Metal: Aluminum.
b. Seal Material: Manufacturer's standard.
1) Color: As selected by Architect from manufacturer's full range.
4. Type: Preformed cellular foam.
a. Foam Material: Manufacturer's standard .
1) Color: As selected by Architect from manufacturer's full range.

2.05 ACCESSORIES

A. Moisture Barriers: Manufacturer's standard moisture barrier consisting of a continuous, waterproof membrane within joint and attached to substrate on sides of joint below the primary cover.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.06 MATERIALS

A. Aluminum: ASTM B 221, Alloy 6063-T5 for extrusions; ASTM B 209, Alloy 6061-T6 for sheet and plate.
   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Elastomeric Seals: ASTM E 1783; preformed elastomeric membranes or extrusions to be installed in metal frames.

C. Compression Seals: ASTM E 1612; preformed elastomeric extrusions having an internal baffle system and designed to function under compression.

D. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.

E. Moisture Barrier: Flexible elastomeric material, PVC, minimum 30 mils thick.

F. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M.

G. Accessories: Manufacturer's standard anchors, clips, fasteners, and other accessories as indicated or required for complete installations.

2.07 ALUMINUM FINISHES

A. Mill finish.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prepare substrates according to expansion control system manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems.

C. Cast-In Frames: Coordinate and furnish frames to be cast into concrete.

3.02 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion control systems.
   1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
   2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper expansion control system installation and performance.
   3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
   4. Repair or grout blockout as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
   5. Install frames in continuous contact with adjacent surfaces.
      a. Shimming is not permitted.
   6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.

C. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
   1. Provide in continuous lengths for straight sections.
   2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
   3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Foam Seals: Install with adhesive recommended by manufacturer.

E. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.

F. Moisture Barrier: Provide at all exterior joints and where indicated on Drawings. Provide drainage fittings where indicated on Drawings.

3.03 PROTECTION

A. Do not remove protective covering until finish work in adjacent areas is complete.

B. Protect the installation from damage by work of other Sections.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   1. Standard hollow-metal doors and frames.
   2. Custom exterior hollow-metal door frames.

B. Related Sections:
   1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

1.02 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.03 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, and finishes.

B. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Amweld International, LLC.
2. Ceco Door Products; an Assa Abloy Group company.
3. Curries Company; an Assa Abloy Group company.
4. Deansteel.
5. Fleming-Baron Door Products.
6. Mesker Door Inc.
7. Pioneer Industries, Inc.
8. Security Metal Products Corp.
9. Steelcraft; an Ingersoll-Rand company.

2.02 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. .
1. Doors:
   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches.
   c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch.
   d. Edge Construction: Model 2, Seamless.
   e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
   f. Core: Manufacturer's standard .
   g. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.
2. Frames:
   a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
   b. Frames: Fabricated from same thickness material as adjacent door frame.
   c. Construction: Full profile welded.
3. Exposed Finish: Prime.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. .
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches.
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
      d. Edge Construction: Model 2, Seamless.
      e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
      f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
      g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
      h. Core: Manufacturer's standard .
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
      b. Construction: Full profile welded.
   3. Exposed Finish: Prime.

2.04 EXTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Commercial Door Frames: NAAMM-HMMA 861; ANSI/SDI A250.4, Physical Performance Level A. .
   1. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, except 0.067 inch for openings exceeding 4 feet wide; with minimum G60 or A60 coating.
      b. Construction: Full profile welded.
   2. Exposed Finish: Prime.

2.05 FRAME ANCHORS

A. Jamb Anchors:
   1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.06 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

2.07 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.08 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.01 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11 for standard and NAAMM-HMMA 840 for custom.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
      a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
      b. Install frames with removable stops located on secure side of opening.
   2. Fire-Rated Openings: Install frames according to NFPA 80.
   3. Floor Anchors: Secure with postinstalled expansion anchors.
      a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
   4. Solidly pack mineral-fiber insulation inside frames.
   5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
   6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
      a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
      c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
   1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   3. Smoke-Control Doors: Install doors according to NFPA 105.

3.03 FIELD QUALITY CONTROL

A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:
   1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.04 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Solid-core flush wood doors with wood-veneer faces.
   2. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Door core materials and construction.
   2. Door edge construction
   3. Door face type and characteristics.
   4. Door louvers.
   5. Door trim for openings.
   6. Door frame construction.
   7. Factory-machining criteria.
   8. Factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
   1. Door schedule indicating door location, type, size, fire protection rating, and swing.
   2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
   3. Details of frame for each frame type, including dimensions and profile.
   4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   5. Dimensions and locations of blocking for hardware attachment.
   6. Dimensions and locations of mortises and holes for hardware.
   7. Clearances and undercuts.
   8. Requirements for veneer matching.
   9. Doors to be factory finished and application requirements.

C. Samples for Verification:
   1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Documentation for composite wood products, indicating compliance with emissions testing or certification.

1.04 CLOSEOUT SUBMITTALS

A. Special warranties.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.

1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Delamination of veneer.
b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Flush Wood Door Manufacturers: Subject to compliance with requirements, unless indicated otherwise, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Masonite Architectural.
2. Lynden Door, Inc.
3. Oregon Door.
4. Oshkosh Architectural Door Company.
5. Poncraft Door Company.
6. Vancouver Door Company.
7. VT Industries Inc.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Composite Wood Products:
      a. Formaldehyde emissions testing or certification.

2.03 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.
   1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.04 VENEERED-FACED FLUSH WOOD DOORS FOR TRANSPARENT FINISH

A. Interior Doors :
   1. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty .
   2. ANSI/WDMA I.S. 1A Grade: Premium.
   3. Faces: Single-ply wood veneer not less than 1/50 inch thick.
      a. Species: As indicated on drawings.
      b. Cut: Plain sliced (flat sliced).
      c. Match between Veneer Leaves: Book match.
      d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
   4. Exposed Vertical and Top Edges: Same species as faces or a compatible species - Architectural Woodwork Standards edge Type A.
   5. Core for Non-Fire-Rated Doors:
      a. ANSI A208.1, Grade LD-1 or Grade LD-2 particleboard.
         1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
   6. Construction: Five or seven plies, stiles and rails bonded to core, with entire unit abrasive planed before veneering.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.05 LIGHT FRAMES AND LOUVERS

A. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated on Drawings. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

2.06 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.
   1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   2. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.
   1. Locate hardware to comply with DHI-WDHS-3.
   2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
   3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
   4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
   5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 "Glazing."

2.07 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.
   1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   2. Finish faces, all four edges, edges of cutouts, and mortises.
   3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:
   1. ANSI/WDMA I.S. 1A Grade: Premium.
   2. Finish: ANSI/WDMA I.S. 1A TR-6 Catalyzed Polyurethane.
   3. Sheen: Satin.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Hardware: For installation, see Section 08 71 00 "Door Hardware."

B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Access doors and frames for walls and ceilings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each door face material.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Provide plans and elevations showing the items described in this Section and coordinated with all building trades.

B. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:
   1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
   2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.02 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Access Panel Solutions.
   2. Acudor Products, Inc.
   3. Alfab, Inc.
   4. Babcock-Davis.
   5. Cendrex Inc.
   6. Elmdor/Stoneman Manufacturing Co.; Div. of Acorn Engineering Co.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

7. Jensen Industries; Div. of Broan-Nutone, LLC.
8. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
9. Karp Associates, Inc.
10. Larsen's Manufacturing Company.
11. Maxam Metal Products Limited.
12. Metropolitan Door Industries Corp.
13. MIFAB, Inc.
14. Milcor Inc.
15. Nystrom, Inc.
16. Williams Bros. Corporation of America (The).

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Flush Access Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: Wall and ceiling.
3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.
a. Finish: Factory prime.
4. Frame Material: Same material, thickness, and finish as door.
5. Hinges: Manufacturer's standard.
6. Hardware: Latch.

D. Flush Access Doors with Concealed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.
a. Finish: Factory prime.
4. Frame Material: Same material and thickness as door.
5. Hinges: Manufacturer's standard.
6. Hardware: Latch.

E. Hardware:
1. Latch: Cam latch operated by screwdriver.

2.03 MATERIALS

A. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

B. Frame Anchors: Same type as door face.

C. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

2.05 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Steel and Metallic-Coated-Steel Finishes:
1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.02 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.03 ACCESS DOORS SCHEDULE

A. Provide access doors and panels as indicated on drawings and at locations required for operation, maintenance, and repair of concealed plumbing valves, HVAC dampers, and other controls that would otherwise be inaccessible.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Fire-rated, insulated service doors.

B. Related Sections:
   1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports.

1.02 SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
   1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
   2. Show locations of controls, locking devices, and other accessories.
   3. Include diagrams for power, signal, and control wiring.

C. Maintenance data.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 UL 10B.
   1. Smoke Control: Where indicated, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10-inch wg for both ambient and elevated temperature tests.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Design Wind Load: As indicated on Drawings.

B. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 FIRE-RATED DOOR ASSEMBLY

A. Fire-Rated Insulated Service Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Cookson Company.
b. Cornell Iron Works, Inc.
c. McKeon Rolling Steel Door Company, Inc.
d. Overhead Door Corporation.

B. Operation Cycles: Door components and operators capable of operating for not less than 10,000.

C. Fire Rating: 3/4 hour.

D. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu.

E. Door Curtain Material: Galvanized steel.

F. Door Curtain Slats: Flat profile slats of 1-7/8-inch center-to-center height.
1. Insulated-Slat Interior Facing: Metal.

G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

H. Hood: Match curtain material and finish.
1. Mounting: As shown on Drawings.

I. Manual Door Operator: Push-up operation.

J. Electric Door Operator:
1. Usage Classification: Heavy duty, 25 or more cycles per hour and over 90 cycles per day.
2. Motor Exposure: Interior.
3. Emergency Manual Operation: Push-up type.
4. Obstruction Detection Device: Automatic photoelectric sensor.
5. Control Station(s): Interior mounted.

K. Curtain Accessories: Equip door with smoke seals, automatic closing device, push/pull handles.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

L. Door Finish:
1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face .

2.03 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.04 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
1. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.05 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.06 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

B. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

C. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism. Automatic-closing device shall be designed for activation by the following:
1. Building fire-detection, smoke-detection, and -alarm systems.

2.07 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.08 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf.

2.09 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.
   1. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
   2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

D. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel. For fire-rated doors, activation delays closing.
   1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
      a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.

E. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
   1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

F. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.

G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Fire-Rated Doors: Install according to NFPA 80.

C. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

D. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. Adjust seals to provide tight fit around entire perimeter.

3.02 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Exterior storefront framing.
   2. Exterior manual-swing entrance doors.

B. Related Sections:
   1. Section 08 81 00 - Glass Glazing: For storefront and entrance glazing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each exposed finish required.

1.03 INFORMATIONAL SUBMITTALS

A. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

B. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.

D. Product test reports.

E. Field quality-control reports.

F. Sample warranties.

G. Maintenance data.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.05 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain all components of aluminum-framed entrances and storefront, including framing and accessories, from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:
   a. Thermal stresses transferring to building structure.
   b. Glass breakage.
   c. Noise or vibration created by wind and thermal and structural movements.
   d. Loosening or weakening of fasteners, attachments, and other components.
   e. Failure of operating units.

C. Structural Loads:
   1. Wind Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:
   1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.

E. Structural: Test according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
   1. Fixed Framing and Glass Area:
      a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
   2. Entrance Doors:
      a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
      b. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 8 lbf/sq. ft..

H. Energy Performance: Certify and label energy performance according to NFRC as follows:
   1. Thermal Transmittance (U-factor):
      a. Fixed glazing and framing areas shall have U-factor of not more than 0.41 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
      b. Thermal Entrance Doors: Door framing and glazing asembly shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
   2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.03 FRAMING

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Arcadia.
   2. Kawneer North America.
   3. Oldcastle Building Envelope.
   4. YKK AP America Inc.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Thermally broken.
   2. Glazing System: Retained mechanically with gaskets on four sides.
   3. Glazing Plane: Front.
   4. Finish: High-performance organic finish.
   5. Fabrication Method: Field-fabricated stick system.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

E. Materials:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209.
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
   c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
   d. Structural Profiles: ASTM B 308/B 308M.
2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.04 THERMAL ENTRANCE DOOR SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   1. Arcadia; Thermal Entrance Door.
   2. Kawneer North America; Insulclad Thermal Entrances.
   3. Oldcastle Building Envelope; AD-375 Medium Stile Thermal Door.
   4. YKK AP America Inc.; Megatherm Doors.

B. Thermal Entrance Doors: Manufacturer's high-performance thermal glazed entrance doors for manual-swing operation.
   1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch- or 2-inch overall thickness, with minimum 0.188-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
   2. Door Design: As indicated.
   3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

2.05 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door to comply with requirements in this Section.
   1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:
   a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbfto set the door in motion and not more than 15 lbf to open the door to its minimum required width.
   b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

C. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

D. Pivot Hinges: BHMA A156.4, Grade 1.
1. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.

E. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.

F. Manual Flush Bolts: BHMA A156.16, Grade 1.

G. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.

H. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

I. Cylinders: As specified in Section 08 71 00 "Door Hardware."

J. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

K. Operating Trim: BHMA A156.6.

L. Removable Mullions: BHMA A156.3, extruded aluminum.
1. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

M. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.

N. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.

O. Weather Stripping: Manufacturer's standard replaceable components.

P. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

Q. Silencers: BHMA A156.16, Grade 1.

R. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

2.06 GLAZING

A. Glazing: Comply with Section 08 81 00 - Glass Glazing.

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.07 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.

B. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

C. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.

2.08 FABRICATION

A. Form or extrude aluminum shapes before finishing.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.09 ALUMINUM FINISHES

A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
   1. Color and Gloss: As indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:
   1. Comply with manufacturer's written instructions.
   2. Do not install damaged components.
   3. Fit joints to produce hairline joints free of burrs and distortion.
   4. Rigidly secure nonmovement joints.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 07 92 00 "Joint Sealants" to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified in Section 08 81 00 "Glass Glazing."

F. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.02 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on representative areas of fixed aluminum-framed storefronts.
1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
a. Perform a minimum of three tests in areas as directed by Architect.

C. Aluminum-framed storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 44 00 - CURTAIN WALL AND GLAZED ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Conventionally glazed aluminum curtain walls with exterior pressure plates and snap-on aluminum trim covers**.**
2. Sun control.
3. Interior aluminum closures, caps, trim, and sill extensions.

B. Related Sections:
1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
2. Section 07 92 00 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
3. Section 08 42 13 "Aluminum-Framed Entrances" for aluminum-framed entrance doors and subframes installed within curtain wall systems.
4. Section 08 81 00 "Glass Glazing" for curtain wall and glazed assemblies glazing.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, details, and attachments to other work.
1. Scale elevations and sections in as large a scale as practical. Include full-scale sections when directed by Architect.
2. When directed by Architect, Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
   a. Joinery, including concealed welds.
   b. Anchorage.
   c. Expansion provisions.
   d. Glazing.
   e. Flashing and drainage.
3. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
4. Provide references to detail numbers shown on drawings and references to specification sections, Article, and paragraph numbers to identify material types and finishes.
5. Provide details showing connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Indicate the plane of primary air and water resistance of both the air / water barrier system and the curtain wall system to which it connects.

C. Samples: For each type of exposed finish required.

1.03 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For glazed aluminum curtain walls and curtain wall mockups, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Preconstruction Laboratory Mockup Testing Submittals:
1. Testing Program: Developed specifically for Project.
2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.

C. Energy Performance Certificates: NFRC-certified energy performance values for each glazed aluminum curtain wall.

D. Product Test Reports: For glazed aluminum curtain walls, for tests performed by a qualified testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For special warranties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Architect, Owner, and their authorized agents shall be provided full access to plant, shop (excluding paint facility), and assembly point to view and inspect the processes and methods employed in the fabrication, assembly, and finishing of the curtain wall.

1.06 WARRANTY

A. Special Assembly Warranty: Manufacturer's or installer's standard form in which manufacturer or installer agrees to repair or replace components of glazed aluminum curtain wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period. The warranty shall state that the exterior curtain wall system is not defective in workmanship or materials and conforms to the final approved Shop Drawings except for reasonable variances not impairing the usefulness of the wall system. The warranty shall apply to both patent and latent defects but does not include ordinary wear and tear, or unusual abuse or neglect, or the acts of omissions of parties other than the curtain wall contractor.
   1. Failures include, but are not limited to, the following:
      a. Failure to meet specified performance requirements.
      b. Structural failures including, but not limited to, excessive deflection.
      c. Noise or vibration caused by thermal movements.
      d. Deterioration of metals and other materials beyond normal weathering.
      e. Water leakage.
      f. Failure of operating components to function normally.
   2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering assemblies that may be incorporated into the Work include, but are not limited to, the following:
   1. Arcadia, Inc.
   2. Kawneer North America, an Arconic company.
   3. Oldcastle, Inc.
   4. Shuco USA LP.
   5. Wausau Window and Wall Systems.
   6. YKK AP America Inc.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Source Limitations: Unless indicated otherwise, obtain all components of glazed framing systems, including framing snap-on mullion components, interior trim, window sills and stools, and accessories, from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazed aluminum curtain walls and mockup support assemblies.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:
a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

C. Structural Loads:
1. Wind-Load Design Pressure: As indicated on Drawings and in accordance with ASCE/SEI 7.

D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches, and to 1/240 of clear span plus 1/4 inch, for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to an amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
3. Cantilever Deflection: Where framing members overhang an anchor point, limited to 2 times the length of cantilevered member, divided by 175.

E. Structural: Test according to ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E283 for infiltration as follows:
1. Fixed Framing and Glass Area:
a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft..

G. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft..
2. Maximum Water Leakage: Defined as the appearance of any water on the interior side of any part of the glazed wall assembly, including the interface locations with adjacent envelope systems, that is not contained and drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water fully contained in drained flashings, gutters, and sills is not considered water penetration. Water that penetrates past the plane of the primary air/water barrier of the curtain wall system shall be considered as water leakage, unless the water is contained within the curtain wall system and is provided a means to drain back to the exterior.

I. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
1. Elastic Displacement (base event): As indicated on drawings.
a. After being subjected to elastic displacement limit, no permanent damage or deformation shall occur and the curtain wall shall meet all performance criteria indicated in this specification without repairs.
2. Inelastic Displacement (maximum considered event): As indicated on drawings.
a. When subjected to the inelastic displacement limit permanent deformation of framing components may occur and glass may break. No component, however, may become dislodged and fall from the building.
3. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at elastic and inelastic displacement.

J. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 or by engineering analysis at design displacement.

K. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.

L. Energy Performance; Vision Areas: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas as a system shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg Fas determined according to NFRC 100.
2. SHGC: Fixed glazing and framing areas as a system shall have a SHGC of no greater than 0.25 as determined according to NFRC 200.

M. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.03 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

B. Glazing System: Retained mechanically with gaskets on four sides and as follows:
1. Aluminum Finishes:
a. Surfaces Exposed to Weather: High-performance organic finish.
b. Interior Surfaces: High-performance organic finish.
2. Fabrication Method: Either factory- or field-fabricated system.
3. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
4. Steel Reinforcement: As required by manufacturer.

C. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
1. Include snap-on aluminum trim that conceals fasteners.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.04 GLAZING

A. Glazing: Comply with Section 08 80 10 "Glass Glazing."

B. Glazing Gaskets: ASTM C509 or ASTM C864. Manufacturer's standard.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Color: Black.

C. Glazing Sealants: As recommended by manufacturer.

2.05 ENTRANCES

A. Entrances: Comply with Division 08 Section "Aluminum-Framed Entrances and Storefronts."

2.06 SUN CONTROL

A. Exterior Fins and Sunshades: Assemblies consisting of manufacturer's standard outriggers, brackets, fins, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.
1. Orientation: As indicated on Drawings.
2. Projection from Wall: As indicated on Drawings.
3. Finish: Match adjacent glazed framing system.

B. Materials:
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
a. Sheet and Plate: ASTM B 209.
b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
d. Structural Profiles: ASTM B 308/B 308M.

2.07 MATERIALS

A. Sheet and Plate: ASTM B209.

B. Metallic Coated Steel Sheet:
1. One of the following:
a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.

C. Stainless Steel: Shall conform to American Iron and Steel Institute's "Steel Products Manual" and the following:
1. Tubing: ASTM A268 or A269.
2. Hot-Finished and Cold Finished Bars and Shapes: ASTM A276.
3. Plate, Sheet and Strip: ASTM A167, A176, or A666
4. Hot-Rolled and Cold-Rolled Sheet and Strip: ASTM A606.

D. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with requirements of the standards indicated below.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Sheet and Plate: ASTM B209.
2. Extruded Bars, Rods, Shapes and Tubes: ASTM B221.
3. Bars, Rods, and Wires: ASTM B211.
4. Standard Structural Shapes: ASTM B308.
5. Sand Casting: ASTM B26.
6. Permanent Mold Castings: ASTM B108.
7. Drawn Seamless Tube: ASTM B210.
8. Extruded Structural Pipe and Tubes: ASTM B429.
9. Die Castings: ASTM B85.

E. Structural Profiles: ASTM B308/B308M.

F. Steel Reinforcement:
1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

G. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

H. Fasteners:
1. Fasteners used to join aluminum to aluminum shall be aluminum or stainless steel.
2. Fasteners used to join stainless steel to stainless steel shall be stainless steel.
3. Exposed fasteners to match finish of curtain wall system.

2.08 SEALANTS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials and not damaging to exposed surfaces.

C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

2.09 ACCESSORY MATERIALS

A. Aluminum Trim: Aluminum sheet meeting ASTM B 209 requirements for alloy and temper recommended by manufacturer and finisher, and with not less than strength and durability properties of Alloy 5005-H32. Form trim components from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Thickness: As required to meet performance requirements, but not less than 0.063 inch.
2. Finish: Match framing, unless otherwise indicated.

B. Anchors: Adjustable anchors designed to accommodate fabrication and installation tolerances, structural loads, and thermal movement, in corrosion-resistant material and finish compatible with adjoining materials and recommended by manufacturer.

2.10 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
7. Components curved to indicated radii.

D. Fabricate components to resist water penetration as follows:
1. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

F. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 08 81 00 - Glass Glazing.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.11 ALUMINUM FINISHES

A. Superior-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer mica finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat.
   1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions .
   2. Color and Gloss: As indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated.

H. Metal Protection:
   1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

J. Install components plumb and true in alignment with established lines and grades.

K. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

L. Install weatherseal sealant according to Section 07 92 00 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.02 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 08 81 00 "Glass Glazing."

3.03 ERECTION TOLERANCES

A. Design and fabricate the glazed curtain wall system to accommodate permissible dimensional tolerances in the building frame and other work adjacent to the wall. Provided irregularities do not exceed them, and clearances in Shop Drawings are maintained, all parts of the curtain wall, when completed, shall be within the following tolerances.
   1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
   2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
      b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
      c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
   4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.04 CLEANING AND PROTECTION

A. Promptly remove from site all debris caused by or incidental to the installation work.

B. Remove from installed Work all mastic smears or other unsightly marks caused by work of this Section. Be responsible for any damage to or disfigurement of work of other trades caused by the Work of this Section.

C. Remove protective coverings from all exposed surfaces, and clean surfaces free of soil and discoloration.

D. Use cleaner acceptable to the stainless steel, aluminum, glass, sealant, gasket and aluminum finishing, and other applicable product manufacturers.
   1. Clean glass in accordance with GANA 01-0116, unless otherwise recommended by manufacturer.

E. Protect curtain wall work against damage by other trades. Any repairs shall be completed in accordance with applicable product manufacturer recommendations.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.05 FIELD QUALITY CONTROL

A. Field-Glazed Structural Silicone Glazed Systems: Engage a site representative qualified by structural silicone sealant manufacturer to inspect substrate conditions; surface preparation; and application of structural silicone sealant.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.

D. Water Penetration and Air Leakage Field Testing:
   1. Notify the Architect and Owner, in writing, a minimum of 14 days prior to conducting the field-testing.
   2. Testing Methodology:
      a. Water Penetration Resistance Testing shall be conducted in accordance with ASTM E1105, Procedure A, consisting of 15 minutes induced air pressure difference.
         1) Field Test pressure shall be two-thirds test pressure specified in the Performance and Testing Requirements section.
         2) Water penetration shall be as defined in the Performance Requirements section.

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware for:

a. Swinging doors.

B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors
6. Installation.
7. Rough hardware.
8. Conduit, junction boxes & wiring.
9. Folding partitions, except cylinders where detailed.
10. Sliding aluminum doors, except cylinders where detailed.
11. Access doors and panels, except cylinders where detailed.

C. Related Sections:

1. Division 01 Section “Alternates” for alternates affecting this section.
2. Division 07 Section “Joint Sealants” for sealant requirements applicable to threshold installation specified in this section.
3. Division 09 sections for touchup finishing or refinishing of existing openings modified by this section.
4. Division 26 sections for connections to electrical power system and for low-voltage wiring.
5. Division 28 sections for coordination with other components of electronic access control system.

1.3 REFERENCES

A. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies

4. UL 305 - Panic Hardware

B. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

C. California Code of Regulations

1. Title 24: California Building Standards Code

1.4 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 requirements.

B. Action Submittals:

1. Product Data: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:

a. Wiring Diagrams: For power, signal, and control wiring and including:
   1) Details of interface of electrified door hardware and building safety and security systems.
   2) Schematic diagram of systems that interface with electrified door hardware.
   3) Point-to-point wiring.
   4) Risers.

3. Samples for Verification: If requested by Architect, submit production sample or sample installations of each type of exposed hardware unit in finish indicated, and tagged with full description for coordination with schedule.

a. Samples will be returned to supplier in like-new condition. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.

4. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:

a. Door Index; include door number, heading number, and Architects hardware set number.
b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
c. Type, style, function, size, and finish of each hardware item.
d. Name and manufacturer of each item.
e. Fastenings and other pertinent information.
f. Location of each hardware set cross-referenced to indications on Drawings.
g. Explanation of all abbreviations, symbols, and codes contained in schedule.
h. Mounting locations for hardware.

i. Door and frame sizes and materials.
j. Name and phone number for local manufacturer's representative for each product.
k. Operational Description of openings with any electrified hardware (locks, exits, electromagnetic locks, electric strikes, automatic operators, door position switches, magnetic holders or closer/holder units, and access control components). Operational description should include how door will operate on egress, ingress, and fire and smoke alarm connection.
   1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work that is critical in Project construction schedule.

5. Key Schedule:

   a. Initiate and conduct meeting(s) with Owner representatives and hardware supplier to determine system keyway(s), keybow styles, structure, stamping, degree of physical security and degree of geographic exclusivity. Furnish Owner’s written approval of the system; do not order keys or cylinders without written confirmation of actual requirements from the Owner.
   b. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
   c. Use ANSI/BHMA A156.28 “Recommended Practices for Keying Systems” as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
   d. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
   e. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
   f. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
      1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.

6. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory prepared for door hardware installation.

C. Informational Submittals:

1. Qualification Data: For Supplier and Installer.
2. Product Certificates for electrified door hardware, signed by manufacturer:

   a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

3. Certificates of Compliance:

   a. Electrified Hardware Coordination Conference Certification: Letter of compliance, signed by Contractor, attesting to completion of electrified hardware coordination conference, specified in “QUALITY ASSURANCE” article, herein.

4. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

1. Operations and Maintenance Data : Provide in accordance with Division 01 and include:

    a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    b. Catalog pages for each product.
    c. Name, address, and phone number of local representative for each manufacturer.
    d. Final approved hardware schedule, edited to reflect conditions as-installed.
    e. Final keying schedule
    f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
    g. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.5 QUALITY ASSURANCE

A. Product Substitutions: Comply with product requirements stated in Division 01 and as specified herein.

    1. Where specific manufacturer's product is named and accompanied by "No Substitute," including make or model number or other designation, provide product specified. (Note: Certain products have been selected for their unique characteristics and particular project suitability.)

        a. Where no additional products or manufacturers are listed in product category, requirements for "No Substitute" govern product selection.

    2. Where products indicate "acceptable manufacturers" or "acceptable manufacturers and products", provide product from specified manufacturers, subject to compliance with specified requirements and "Single Source Responsibility" requirements stated herein.

B. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project.

    1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
    2. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
    3. Coordination Responsibility: Coordinate installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.

        a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.

C. Installer Qualifications: Qualified tradesmen, skilled in application of commercial grade hardware with record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.

D. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

    1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.
    2. Manufacturers that perform electrical modifications and that are listed by testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

E. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

F. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.

G. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

H. Means of Egress Doors: Latches do not require more than 5 lbs (67 N) to release latch. Locks do not require use of key, tool, or special knowledge for operation.

I. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in “REFERENCES” article, herein.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of wrist and that operate with force of not more than 5 lbs (22.2 N).
2. Maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbs (22.2 N) applied perpendicular to door.
b. Sliding or Folding Doors: 5 lbs (22.2 N) applied parallel to door at latch.
c. Fire Doors: The minimum opening force allowable by the appropriate administrative authority, not to exceed 15 lbs (66.7N).

3. Bevel raised thresholds with slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
4. Adjust closer so that the time required to move the door from the 90 degree position to 12 degrees from the latch is 5 seconds minimum.

J. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Inspect and discuss preparatory work performed by other trades.
3. Inspect and discuss electrical roughing-in for electrified door hardware.
4. Review sequence of operation for each type of electrified door hardware.
5. Review required testing, inspecting, and certifying procedures.

K. Coordination Conferences:

1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.

a. Attendees: Door hardware supplier, door hardware installer, Contractor.
b. After meeting, provide letter of compliance to Architect, indicating when meeting was held and who was in attendance.

2. Electrified Hardware Coordination Conference: Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

    a. Attendees: electrified door hardware supplier, doors and frames supplier, electrified door hardware installer, electrical subcontractor, Owner, Owner's security consultant, Architect and Contractor.
    b. After meeting, provide letter of compliance to Architect, indicating when coordination conference was held and who was in attendance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

    1. Deliver each article of hardware in manufacturer's original packaging.

C. Project Conditions:

    1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
    2. Provide secure lock-up for door hardware delivered to Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

D. Protection and Damage:

    1. Promptly replace products damaged during shipping.
    2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
    3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

E. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.7 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings:

1. Prior to submittal, carefully inspect existing conditions to verify finish hardware required to complete Work, including sizes, quantities, existing hardware scheduled for re-use, and sill condition material. If conflict between the specified/scheduled hardware and existing conditions, submit request for direction from Architect. Include date of jobsite visit in the submittal.
2. Submittals prepared without thorough jobsite visit by qualified hardware expert will be rejected as non-compliant.

F. Direct shipments not permitted, unless approved by Contractor.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Years from date of Substantial Completion, for durations indicated.

a. Closers:
1) Mechanical: 30 years.

b. Automatic Operators: 2 years
c. Exit Devices:
1) Mechanical: 3 years.
2) Electrified: 1 year.

d. Locksets:
1) Mechanical: 3 years.
2) Electrified: 1 year.

e. Continuous Hinges: Lifetime warranty
f. Key Blanks: Lifetime

2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

1.9 MAINTENANCE

A. Maintenance Tools:

1. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.10 REGULATORY REQUIREMENTS:

A. Locate latching hardware between 34 inches to 44 inches above the finished floor, per 2022 California Building Code, Section 11B-404.2.7.

1. Panic hardware: locate between 36 inches to 44 inches above the finished floor.

B. Handles, pull, latches, locks, other operable parts:

1. Readily openable from egress side with one hand and without tight grasping, tight pinching, or twisting of the wrist to operate. 2022 California Building Code Section 11B-309.4.
2. Force required to activate the operable parts: 5.0 pounds maximum, per 2022 California Building Code Section 11B-309.4.

C. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2022 California Building Code Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.

1. Exception: exterior doors' pressure-to-open may be increased to 8.5-pounds if: at a single location, and one of a bank of eight leafs or fraction of eight, and one leaf of this bank is fitted with a low- or high-energy operator.

D. Low-energy powered doors: comply with ANSI/BHMA A156.19. Reference: 2022 California Building Code Section 11B-404.2.9, Exception 2.

1. Where powered door serves an occupancy of 150 or more, provide back-up battery power or stand-by generator power, capable of supporting a minimum of 100 cycles.
2. Actuators, vertical bar type: minimum 2-inches wide, 30-inches high, bottom located minimum 5-inches above floor or ground, top located minimum 35-inches above floor or ground. Displays International Symbol of Accessibility, per 2022 California Building Code Section 11B-703.7.
3. Actuators, plate type: use two at each side of the opening. Minimum 4-inches diameter or 4-inches square. Displays International Symbol of Accessibility, per 2022 California Building Code Section 11B-703.7. Locate centerline of lower plate between 7- and 8-inches above floor or ground, and upper plate between 30- and 44-inches above floor or ground.
4. Actuator location: conspicuously located, clear and level floor/ground space for forward or parallel approach.

E. Adjust door closer sweep periods so that from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 12 degrees from the latch, measured to the landing side of the door, per 2022 California Building Code Section 11B-404.2.8.

1. Spring hinges: adjust for 1.5 seconds minimum for 70 degrees to fully-closed.

F. Smooth surfaces at bottom 10 inches of push sides of doors, facilitating push-open with wheelchair footrests, per 2022 California Building Code Section 11B-404.2.10.

1. Applied kickplates and armor plates: bevel the left and right edges; free of sharp or abrasive edges.
2. Tempered glass doors without stiles: bottom rail may be less than 10 inches if top leading edge is tapered 60 degrees minimum.

G. Door opening clear width no less than 32 inches, measured from face of frame stop, or edge of inactive leaf of pair of doors, to door face with door opened to 90 degrees. Hardware projection not a factor in clear width if located above 30 inches and below 80 inches, and the hardware projects no more than 4 inches. 2022 California Building Code Section 11B-404.2.3.

1. Exception: In alterations, a projection of 5/8 inch (15.9 mm) maximum into the required clear width shall be permitted for the latch side stop.
2. Door closers and overhead stops: not less than 78 inches above the finished floor or ground, per 2022 California Building Code 11B-307.4.

H. Thresholds: floor or landing no more than 0.50 inches below the top of the threshold of the doorway, per 2022 California Building Code Section 11B-404.2.5. Vertical rise no more than 0.25 inches, change in level between 0.25 inches and 0.50 inches: beveled to slope no greater than 1:2 (50 percent slope). 2022 California Building Code Section 11B-303.2 & ~.3.

I. Floor stops: Do not locate in path of travel. Locate no more than 4 inches from walls, per DSA Policy #99-08 (Access).

J. Pairs of doors with independently-activated hardware both leafs: limit swing of right-hand or right-hand-reverse leaf to 90 degrees to protect persons reading wall-mounted tactile signage, per 2022 California Building Code Section 11B-703.4.2.

K. Door and door hardware encroachment: Doors, when fully open, shall not reduce the required width by more than 7 inches. Doors in any position shall not reduce the required width by more than one-half. 2022 California Building Code, Section 1005.7.1.

1. In I-2 occupancies, surface mounted latch release hardware is not permitted to project in the required egress width, regardless of its mounting height, per 2022 California Building Code, Section 1005.7.1 at Exception 1.

L. In groups I-2 or I-2.1 occupancies, doors serving as a means of egress where used for the movement of beds and stretcher patients shall provide a minimum clear opening width of 44 inches. At pair openings that includes two door leaves without a mullion, one leaf shall provide a minimum clear opening width of 44 inches. 2022 California Building Code, Section 1010.1.1.

M. In group I-2 or I-2.1 occupancies, there shall be no projections into the clear width of doors used for the movement of beds and stretcher patients in the means of egress. 2022 California Building Code, Section 1010.1.1.1 at Exception 2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where “No Substitute” is noted, submittals and substitution requests for other products will not be considered.

B. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturer” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

C. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.

D. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

E. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.2 MATERIALS

A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
4. Install hardware with fasteners provided by hardware manufacturer.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.

1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
2. Use materials which match materials of adjacent modified areas.
3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.3 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Ives 5BB series
2. Acceptable Manufacturers and Products: No Substitute

B. Requirements:

1. Provide five-knuckle ball bearing hinges conforming to ANSI/BHMA A156.1.
2. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:

   a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
   b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high

3. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:

   a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high

4. 2 inches or thicker doors:

   a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high

5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.

6. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

    a. Steel Hinges: Steel pins
    b. Non-Ferrous Hinges: Stainless steel pins
    c. Out-Swinging Exterior Doors: Non-removable pins
    d. Out-Swinging Interior Lockable Doors: Non-removable pins
    e. Interior Non-lockable Doors: Non-rising pins

8. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.
9. Doors 36 inches (914 mm) wide or less furnish hinges 4-1/2 inches (114 mm) high; doors greater than 36 inches (914 mm) wide furnish hinges 5 inches (127 mm) high, heavy weight or standard weight as specified.
10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component.
11. Provide mortar guard for each electrified hinge specified.
12. Provide spring hinges where specified. Provide two spring hinges and one bearing hinge per door leaf for doors 90 inches (2286 mm) or less in height. Provide one additional bearing hinge for each 30 inches (762 mm) of additional door height.

2.4 ELECTRIC POWER TRANSFER

A. Manufacturers:

    a. Scheduled Manufacturer: Von Duprin EPT-10

B. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires sufficient to accommodate electric function of specified hardware.

C. Locate electric power transfer per manufacturer’s template and UL requirements, unless interference with operation of door or other hardware items.

2.5 FLUSH BOLTS

A. Manufacturers:

    1. Scheduled Manufacturer: Ives

B. Requirements:

    1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.6 COORDINATORS

A. Manufacturers:

1. Scheduled Manufacturer: Ives

B. Requirements:

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers and surface vertical rod exit device strikes. Factory-prep coordinators for vertical rod devices if required.

2.7 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Schlage L9000 series
2. Acceptable Manufacturers and Products: No Substitute

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1 Operational, Grade 1 Security, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
2. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.
3. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
4. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide a request to exit (RX) switch that is actuated with rotation of inside lever.
5. Provide motor based electrified locksets with electrified options as scheduled in the hardware sets and comply with the following requirements:

    a. Universal input voltage – single chassis accepts 12 or 24V DC to allow for changes in the field without changing lock chassis.
    b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case
    c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
    d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
    e. Request to Exit Switch (RX) –
        1) Modular Design – provide electrified locks capable of using, adding, or changing a modular RX switch without opening the lock case.
        2) Monitoring – where scheduled, provide a request to exit (RX) switch that detects rotation of the inside lever.

    f. Connections – provide quick-connect Molex system standard.
    g. UL Listed – 3 hour fire door

6. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.

    a. Lever Design: As scheduled.

2.8 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Von Duprin 98 series
2. Acceptable Manufacturers and Products: No Substitute

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1, and UL listed for Panic Exit or Fire Exit Hardware. Cylinders: Refer to “KEYING” article, herein.
2. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
3. Touchpad: Extend minimum of one half of door width. Match exit device finish, stainless steel for US26, US26D, US28, US32, and US32D finishes; and for all other finishes, provide compatible finish to exit device. No plastic inserts are allowed in touchpads.
4. Provide exit devices with dead-latching feature for security and for future addition of alarm kits and/or other electrified requirements.
5. Provide flush end caps for exit devices.
6. Provide exit devices with manufacturer’s approved strikes.
7. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
8. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
9. Provide cylinder dogging at non-fire-rated exit devices.
10. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
11. Where lever handles are specified as outside trim for exit devices, provide heavy-duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.

    a. Lever Style: Match lever style of locksets.

12. Accessibility: Maximum 5lbs force to retract latch bolt per CBC Chapter 11B.

    “AX” feature: touchpad directly retracts the latchbolt with 5 lb or less of force. Provide testing lab certification confirming that the mechanical device is independent third-party tested to meet this 5 lb requirement.

13. Provide UL labeled fire exit hardware for fire rated openings.
14. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
15. Provide electrified options as scheduled.

2.9 ELECTRONIC ACCESS CONTROL LOCKSETS AND EXIT DEVICE TRIM

A. Manufacturers:

1. Scheduled Manufacturer: To establish standard of quality and design intent, electronic access control locksets and exit device trim specifications have been based on Schlage. Products of other manufacturers meeting or exceeding design and performance requirements specified herein will be considered for substitution subject to compliance with provisions of Division 01 Section “Product Requirements.”
2. Scheduled Manufacturer and Product: Schlage AD series.
3. Acceptable Manufacturers and Products: No substitute.

B. Product: Schlage AD-300-MS adaptable mortise-type electronic locksets.

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1 Operational, Grade 1 Security, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Provide lock case that is field reversible for handing without opening case.
2. Backset: 2-3/4-inch (70 mm), nominal.
3. Latchbolt: 3-piece, beveled, stainless steel with 3/4-inch (19 mm) throw and anti-friction latch.
4. Deadbolt: Where deadbolt function is scheduled, provide stainless steel deadbolt interconnected with latch 1-5/8-inch (41 mm) high and 5/8-inch (16 mm) thick with 1-inch throw.
5. Chassis: ANSI/BHMA standard mortise lock prep for 1-3/4-inch (44 mm) doors

C. Product: Schlage AD-300-993 adaptable electronic exit device trim.

1. Provide exit device trim conforming to ANSI/BHMA A156.25, non-handed, field-reversible.
2. Exit Device Configurations: Exit device lever trim to retract latchbolt for following exit device applications:

    a. Rim

3. Exit Device Compatibility: Provide exit device trim with universal mounting plate enabling operation as required.

D. Requirements:

1. Provide adaptable electronic access control products that comply with the following requirements:

    a. Listed, UL 294 - The Standard of Safety for Access Control System Units.
    b. Compliant with ANSI/BHMA A156.25 Grade 1 Operation and Security.
    c. Certified to UL10C, FCC Part15, Florida Building Code Standards TAS 201 large missile impact, TAS 202 and TAS 203.
    d. Compliant with ASTM E330 for door assemblies.
    e. Compliant with ICC / ANSI A117.1, NFPA 101, NFPA 80, and Industry Canada IC.

2. Functions: Provide functions as scheduled that are field configurable without taking the adaptable electronic product off the door.
3. Emergency Override: Provide mechanical key override; cylinders: Refer to “KEYING” article, herein.
4. Levers:

a. Vandal Resistance: Exterior (secure side) lever rotates freely while door remains locked, preventing damage to internal lock components from vandalism by excessive force.
b. Provide non-handed lever trim that operates independently of non-locking levers.
c. Style: Rhodes (06)
d. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.

5. Power Supply:

   a. Offline – access control rights stored on device and access control rights stored on magnetic stripe credential
      1) Adaptable electronic access control products powered by four AA batteries with options for eight AA batteries or a 12V or 24V DC power supply.
      2) Provide adaptable electronic access control products with the ability to communicate battery status.

   b. Networked – hardwired
      1) Adaptable electronic access control products powered by 12VDC or 24VDC power supply with max current draw not to exceed 250mA.

   c. Networked – wireless
      1) Adaptable electronic access control products powered by four AA batteries with options for eight AA batteries or a 12V or 24V DC power supply.
      2) Provide adaptable electronic access control products with the ability to communicate battery status and battery voltage level by means of a handheld programming device at door and remotely by Partner integrated software.

6. Features:

   a. Audible feedback that can be enabled or disabled.
   b. Tamper-Resistant Screws: Tamper torx screws on inside escutcheon for increased security.
   c. Offline – access control rights stored on device
      1) Visual tri-colored LED indicators that indicate activation, additional PIN code credential required, operational systems status, system error conditions and low power conditions.
      2) Visual bi-colored LED indicator on interior that is capable of indicating secured/unsecured status of device to occupants on interior.
      3) Onboard processor with memory capacity of 5,000 users, 5,000 event audit history, up to 16 time zones and up to 32 calendar events.

   d. Offline – access control rights stored on magnetic stripe credential
      1) Visual tri-colored LED indicators that indicate activation, operational systems status, system error conditions and low power conditions.
      2) Onboard processor with memory capacity of 10,000 event audit history, up to 16 time zones and up to 32 calendar events.

   e. Networked – hardware and wireless
      1) Ability to communicate unit’s communication status.
      2) Visual tri-colored LED indicators that indicate activation, additional PIN code credential required, operational systems status, system error conditions and low power conditions.

3) Visual bi-colored LED indicator on interior that is capable of indicating secured/unsecured status of device to occupants on interior.

7. Adaptability:

   a. Field changeable Reader Modules: Adaptable electronic access control products to have the ability to change credential reader technologies without being removed from door.
   b. Offline
      1) Networking Capabilities: Network adaptable without removing device from door. Adaptable electronic access control products to have the ability to be upgraded in the field from a standalone battery powered configuration to a wireless networked configuration without being removed from the door.

   c. Networked
      1) Open Architecture: Adaptable electronic access control products manufactured with open architecture characteristics capable of handling new and existing access control software and credential reading technology.

8. Switches: Provide adaptable electronic access control products with the following switches, standard:

   a. Door Position Switch
   b. Interior Cover Tamper Guard
   c. Mechanical Key Override
   d. Request to Exit
   e. Request to Enter
   f. Lock/Unlock Status (Clutch Position).

9. Credential Reader:

   a. Networked – hardwired
      1) Credential Reader Configuration: Provide credential reader modules in the following configurations, as indicated in door hardware sets. Multi-tech contactless reader shall be NFC-Compatible and read access control data from both 125 kHz and 13.56 MHz contactless smart cards. The multi-tech contactless reader shall be optimally designed for use in access control applications that require reading both 125 kHz proximity and 13.56 MHz contactless smart cards.
         a) Proximity, Smartcard via Multi-Technology.
         b) Proximity, Smartcard via Multi-Technology and keypad.
      2) Credential Reader Capabilities: Provide credential readers capable of being configured at lockset with handheld programming device and remotely operated with the following integrated software partners.
         a) 13.56 MHz Smart card credentials:
            i. Secure section (Multi-Technology and Smartcard): Schlage MIFARE Classic, Schlage MIFARE DESFire EV1, PIV and PIV-I Compatible
            ii. 13.56 MHz Serial number only (Multi-Technology and Smartcard): MIFARE, DESfire, HID iClass, MIFARE DESFire EV1
            iii. 125 kHz Proximity card credentials: Schlage, XceedID, HID, GE/CASI ProxLite and AWID.
         b) Multi-Technology readers that read both 13.56 MHz Smart Cards and 125 kHz Prox cards.
         c) Dual credential reading capabilities credential card or fob and PIN.

10. Operation:

    a. Networked – hardwired
        1) Adaptable electronic access control product system interface:
            a) Wiegand or Clock & Data via PIB300 (Panel Interface Board).
            b) Directly via RS485.
        2) Adaptable electronic access control products to have real-time bidirectional communication between access control system and lock.
        3) Credential Verification Time: less than 1 second.
        4) When Utilized with Partner Integrated Access Control Network Software With Remote Commanding Capability: Provide adaptable electronic access control product with the ability to be remotely locked down or unlocked within 10 seconds or less, without user interface at the device.
        5) Upon Loss of Power to Device: Provide adaptable electronic access control product with the ability to manage access control offline in one of three methods below that can be configured in the field at lockset by handheld programming device and remotely by Partner integrated software:
            a) Fail locked (secured)
            b) Fail unlocked (unsecured)
            c) Fail As-Is
        6) Upon Loss of Communication Between Device and Network: Provide adaptable electronic access control product with the ability to manage access control offline in one of four methods below that can be configured in the field at device by handheld programming device and remotely by Partner integrated software:
            a) Fail locked (secured)
            b) Fail unlocked (unsecured)
            c) Fail As-Is
            d) Fail to Degraded/cache mode utilizing cache memory with following selectable options:
                i. Grant access up to the last 1,000 unique previously accepted User IDs.
                ii. Grant access up to the last 1,000 unique previously accepted facility/site codes.
                iii. Remove from cache previously stored User IDs or facility/site codes that have not been presented to lock within the last 5 days.
        7) Provide adaptable electronic access control product with the ability to be configured at door by handheld programming device and remotely by Partner integrated software the length of time device is unlocked upon access grant.
        8) Provide adaptable electronic access control product with the ability to communicate identifying information such as firmware versions, hardware versions, serial numbers, and manufacturing dates by handheld programming device and remotely by Partner integrated software.

E. Components

    1. Product: Schlage HHD series with Utility Software.

        a. Provide Handheld Programming Device for adaptable electronic access control products capable of the following minimum requirements.
            1) Capable of initializing lock and accessories using preloaded software.
            2) Utilized to field configure electronic access control devices, to download firmware updates and door files to device, and to download audit files from device.

    2. Product: Schlage PIB300-2D Panel Interface Board.

a. Provide Panel Interface Board for hardwired adaptable electronic access control products capable of the following minimum requirements.
   1) Used to connect hardwired adaptable electronic access control products to the access control board or reader interface board, where Wiegand or Clock & Data protocol is required.
   2) Applicable Standards:
      a) Listed, UL 294 - The Standard of Safety for Access Control System Units.
      b) Compliant with NEMA 1, 4, 4X, 6.
      c) Certified to FCC Part15, Florida Building Code Standards.
      d) Compliant to ASTM E3300 and IC (Canada).
   3) Power Supply: 12VDC or 24VDC.
   4) Status Indicators: 13 LEDs minimum.

2.10 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Schlage or Von Duprin PS900 series

B. Requirements:

1. Provide power supplies, recommended and approved by manufacturer of electrified locking component, for operation of electrified locks, electrified exit devices, magnetic locks, electric strikes, and other components requiring power supply.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply , and UL class 2 listed.
4. Options:

   a. Provide power supply, where specified, with internal capability of charging sealed backup batteries 24 VDC, in addition to operating DC load.
   b. Provide sealed batteries for battery back-up at each power supply where specified.
   c. Provide keyed power supply cabinet.

5. Provide power supply in an enclosure, complete, and requiring 120VAC to fused input.
6. Provide power supply with emergency release terminals, where specified, that allow release of all devices upon activation of fire alarm system complete with fire alarm input for initiating “no delay” exiting mode.

2.11 CYLINDERS

A. Manufacturers:

1. Scheduled Manufacturer: Schlage SFIC Everest RP
2. Acceptable Manufacturers: No Substitute

B. Requirements:

1. Provide permanent small format interchangeable core (SFIC) cylinders/cores to match Owner’s existing key system, compliant with ANSI/BHMA A156.5; latest revision, Section

12, Grade 1; permanent cylinders; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

2. Replaceable Construction Cores.

    a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
        1) 3 construction control keys
        2) 12 construction change (day) keys.

    b. Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2.12 KEYING

A. Provide cylinders/cores keyed into Owner's existing factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.

    a. Master Keying system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Owner.
3. Provide keys with the following features:

    a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)

4. Identification:

    a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication "Keying Systems and Nomenclature" for identification. Blind code marks shall not include actual key cuts.
    b. Identification stamping provisions must be approved by the Architect and Owner.
    c. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
    d. Failure to comply with stamping requirements shall be cause for replacement of keys involved at no additional cost to Owner.
    e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

5. Quantity: Furnish in the following quantities.

    a. Change (Day) Keys: 3 per cylinder/core.
    b. Permanent Control Keys: 3.
    c. Master Keys: 6.

2.13 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer: Telkee
2. Acceptable Manufacturers: HPC, Lund

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.

    a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
    b. Provide hinged-panel type cabinet for wall mounting.

2.14 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: LCN 4040XP series.
2. Acceptable Manufacturers and Products: No Substitute

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.15 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer: Ives
2. Acceptable Manufacturers: No Substitute

B. Requirements:

1. Provide push plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick and beveled 4 edges. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
2. Provide push bars of solid bar stock, diameter and length as scheduled. Provide push bars of sufficient length to span from center to center of each stile. Where required, mount back to back with pull.
3. Provide offset pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
4. Provide flush pulls as scheduled. Where required, provide back-to-back mounted model.
5. Provide pulls of solid bar stock, diameter and length as scheduled. Where required, mount back to back with push bar.
6. Provide pull plates 4 inches (102 mm) wide by 16 inches (406 mm) high by 0.050 inch (1 mm) thick, beveled 4 edges, and prepped for pull. Where width of door stile prevents use of 4 inches (102 mm) wide plate, adjust width to fit.
7. Provide wire pulls of solid bar stock, diameter and length as scheduled.
8. Provide decorative pulls as scheduled. Where required, mount back to back with pull.

2.16 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer: Ives
2. Acceptable Manufacturers: No Substitute

B. Requirements:

1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes of plates:

    a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
    b. Mop Plates: 4 inches (102 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
    c. Armor Plates: 36 inches (914 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

2.17 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers: Glynn-Johnson

B. Requirements:

1. Provide heavy duty concealed mounted overhead stop or holder as specified for exterior and interior vestibule single acting doors.
2. Provide heavy duty concealed mounted overhead stop or holder as specified for double acting doors.
3. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
4. Where overhead holders are specified provide friction type at doors without closer and positive type at doors with closer.

2.18 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives
2. Acceptable Manufacturers: No Substitute

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

2.19 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer: Zero International

B. Requirements:

1. Provide thresholds, weather-stripping (including door sweeps, seals, and astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
2. Size of thresholds:

   a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
   b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width

3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

2.20 FINISHES

A. Finish: BHMA 626/652 (US26D); except:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Continuous Hinges: BHMA 628 (US28)

3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Latch Protectors: BHMA 630 (US32D)
9. Weatherstripping: Clear Anodized Aluminum
10. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Existing frames and doors to be retrofitted with new hardware**:**

1. Field-verify conditions and dimensions prior to ordering hardware. Fill existing hardware cut outs not being reused by the new hardware. Remove existing hardware not being reused, return to Owner unless directed otherwise.
2. Remove existing floor closers not scheduled for reuse, fill cavities with non-shrinking concrete and finish smooth.
3. Cut and weld existing steel frames currently prepared with 2.25 inch height strikes. Cut an approximate 8 inch section from the strike jamb and weld in a reinforced section to accommodate specified hardware’s strike.
4. Patch and weld flush filler pieces into existing door hardware preparations in steel doors and frames, leave surfaces smooth.

3.2 PREPARATION

A. Where on-site modification of doors and frames is required:

1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
2. Field modify and prepare existing door and frame for new hardware being installed.
3. When modifications are exposed to view, use concealed fasteners, when possible.
4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:

a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

H. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying section.

I. Wiring: Coordinate with Division 26, ELECTRICAL sections for:

1. Conduit, junction boxes and wire pulls.
2. Connections to and from power supplies to electrified hardware.
3. Connections to fire/smoke alarm system and smoke evacuation system.
4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
5. Testing and labeling wires with Architect's opening number.

J. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Architect.

L. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

M. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

1. Coordination: Coordinate provision with the security systems provider to mitigate excessive or redundant purchase.

2. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.

N. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

O. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

P. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

Q. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

R. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

S. Field-verify existing conditions and measurements prior to ordering hardware. Fill existing hardware cut outs not being used by the new hardware.

T. Remove existing hardware not being reused. Tag and bag removed hardware, turn over to Owner.

U. Where existing wall conditions will not allow door to swing using the scheduled hinges, provide wide-throw hinges and if needed, extended arms on closers.

V. Provide manufacturer’s recommended brackets to accommodate the mounting of closers on doors with flush transoms.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

A. Provide training for Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.7 DOOR HARDWARE SCHEDULE

A. Locksets, exit devices, and other hardware items are referenced in the following hardware sets for series, type and function. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.

B. Do not order material until submittal has been reviewed, stamped, and signed by Architect’s door hardware consultant.

C. Hardware Sets:

ARROYO HS – NEW THEATER & ADMINISTRATION BUILDING
EL MONTE, CALIFORNIA
DSA SUBMITTAL
31 MARCH 2024

96199 OPT0335096 Version 1

HW SET: 01

Door(s):
A101

B100.1	B100.2	B100.3	B100	B149.1	
2 EA	CONT. HINGE	112XY EPT		628	IVE
2 EA	POWER TRANSFER	EPT10		689	VON
1 EA	REMOVABLE MULLION	KR4954 STAB		689	VON
1 EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-EO		626	VON
1 EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-NL-OP-110MD		626	VON
1 EA	MULLION STORAGE KIT	MT54		689	VON
1 EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
1 EA	SFIC RIM CYLINDER	80-159 GRN		626	SCH
2 EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1 EA	DOOR PULL	VR910 DT SNB		630	IVE
1 EA	DOOR PULL	VR910 NL SNB		630	IVE
2 EA	OH STOP	100S		630	GLY
2 EA	SURFACE CLOSER	4040XP EDA PROVIDE MTG BRKT, SPCR & PLATE AS REQ'D		689	LCN
1 EA	MULLION SEAL	8780NBK PSA		BK	ZER
1 SET	SEALS	BY DOOR/FRAME MFR			B/O
2 EA	DOOR SWEEP	39A		A	ZER
1 EA	THRESHOLD	102A OR AS DETAILED		A	ZER
2 EA	DOOR CONTACT	679-05HM/WD		BLK	SCE
1 EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1		CARD READER - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR.
** = CONSULT DISTRICT FOR KEYING DETAILS

ARROYO HS – NEW THEATER & ADMINISTRATION BUILDING
EL MONTE, CALIFORNIA
DSA SUBMITTAL
31 MARCH 2024

HW SET: 02

Door(s):

B149

1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-NL-OP-110MD		626	VON
1	EA	SFIC RIM CYLINDER	80-159 GRN		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	DOOR PULL	VR910 NL SNB		630	IVE
1	EA	SURFACE CLOSER	4040XP EDA PROVIDE MTG BRKT, SPCR & PLATE AS REQ'D		689	LCN
1	EA	FLOOR STOP	FS18S/FS18L		BLK	IVE
1	SET	SEALS	BY DOOR/FRAME MFR			B/O
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1	EA	DOOR CONTACT	679-05HM/WD		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1			CARD READER - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR.
** = CONSULT DISTRICT FOR KEYING DETAILS

ARROYO HS – NEW THEATER & ADMINISTRATION BUILDING
EL MONTE, CALIFORNIA
DSA SUBMITTAL
31 MARCH 2024

HW SET: 03

Door(s):

A104.1 A116 B118.1 B118.2

1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-PA-AX-98-EO		626	VON
1	EA	ELEC EXIT DEVICE TRIM	*AD-300-993R-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP EDA PROVIDE MTG BRKT, SPCR & PLATE AS REQ'D		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS18S/FS18L		BLK	IVE
1	SET	SEALS	BY DOOR/FRAME MFR			B/O
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR
* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

ARROYO HS – NEW THEATER & ADMINISTRATION BUILDING
EL MONTE, CALIFORNIA
DSA SUBMITTAL
31 MARCH 2024

HW SET: 04

Door(s):

A137.1

1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP EDA PROVIDE MTG BRKT, SPCR & PLATE AS REQ'D		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS18S/FS18L		BLK	IVE
1	SET	SEALS	BY DOOR/FRAME MFR			B/O
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR
* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

ARROYO HS – NEW THEATER & ADMINISTRATION BUILDING
EL MONTE, CALIFORNIA
DSA SUBMITTAL
31 MARCH 2024

HW SET: 05

Door(s):

A129 B125.1 B125.2

2	EA	CONT. HINGE	112XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10		689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
2	EA	ELEC PANIC HARDWARE	RX-LC-PA-AX-98-EO		626	VON
1	EA	MULLION STORAGE KIT	MT54		689	VON
1	EA	ELEC EXIT DEVICE TRIM	*AD-300-993R-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4040XP EDA PROVIDE MTG BRKT, SPCR & PLATE AS REQ'D		689	LCN
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
1	SET	SEALS	BY DOOR/FRAME MFR			B/O
2	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR.
* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 06

Door(s):

B119

1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
1	SET	SEALS	BY DOOR/FRAME MFR			B/O
1			POWER SUPPLY - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR
* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 07

Door(s):

B134

1	EA	CONT. HINGE	112XY EPT		628	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	SET	SEALS	BY DOOR/FRAME MFR			B/O
1			POWER SUPPLY - WORK OF DIVISION 28			

WIDE STILE ALUMINUM DOOR
* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 08

Door(s):

A119	A120	A121	A124	A125	A126
A127	A130	A131	A132	A133	A135
A136	A137				

1	EA	SLIDING DOOR	OFFICESLIDE SYSTEM, SECTION 08 34 00		ADS
1	EA	SLIDING DOOR OFFICE	AD5450B-LP-630-I LOCKED/UNLOCKED INDICATOR ON THUMBTURN SIDE	630	ADS
1	EA	SFIC EVEREST CORE	**80-037 EV29 R	626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN		SCH

** = CONSULT DISTRICT FOR KEYING DETAILS
CYLINDER CORES SUPPLIED BY 08 71 00
ALL OTHER HARDWARE LISTED FOR REFERENCE ONLY. SUPPLIED WITH AD SYSTEMS SLIDER

HW SET: 09

Door(s):

B118 B125

2	SET	CAM LIFT HINGES	BY ACCOUSTIC DOOR/FRAME MFR			B/O
2	EA	POWER TRANSFER	EPT10		689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
2	EA	ELEC PANIC HARDWARE	RX-LC-PA-AX-98-EO		626	VON
1	EA	MULLION STORAGE KIT	MT54		689	VON
1	EA	ELEC EXIT DEVICE TRIM	*AD-300-993R-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
2	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
2	EA	WALL STOP	WS406/407CCV		630	IVE
1	SET	SOUND SEALS	BY ACCOUSTIC DOOR/FRAME MFR.			B/O
1	EA	THRESHOLD	BY ACCOUSTIC DOOR/FRAME MFR.			
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR Ttemplating PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 10

Door(s):

B107.2 B107.1

2	SET	CAM LIFT HINGES	BY ACCOUSTIC DOOR/FRAME MFR			B/O
2	EA	POWER TRANSFER	EPT10		689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-DT-06		626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-NL-06		626	VON
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
1	EA	SFIC RIM CYLINDER	80-159 GRN		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
2	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
2	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
1	SET	SOUND SEALS	BY ACCOUSTIC DOOR/FRAME MFR.			B/O
1	EA	THRESHOLD	BY ACCOUSTIC DOOR/FRAME MFR.			
2	EA	DOOR CONTACT	679-05HM/WD		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS-FA 900-BBK 120/240 VAC			VON
1			CARD READER - WORK OF DIVISION 28			

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 11

Door(s):

A103 A137.2

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050HD 06A L583-363 L283-711		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 12

Door(s):
A106-B

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050HD 06A L583-363 L283-711		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 13

Door(s):
B113

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	CLASSROOM SECURITY	L9071HD 06A L283-711		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 14

Door(s):
B123

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	CLASSROOM SECURITY	L9071HD 06A L283-711		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 15

Door(s):
B115 B116

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	CLASSROOM SECURITY	L9071HD 06A L283-711		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 16

Door(s):
B138

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	CLASSROOM SECURITY	L9071HD 06A L283-711		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 17

Door(s):
A104

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 18

Door(s):
B131 B131.1

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 19

Door(s):
A105

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	OFFICE W/SIM RETRACT	L9056HD 06A L583-363 L283-722		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 20

Door(s):
B129 B130 B142 B143

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	OFFICE W/SIM RETRACT	L9056HD 06A L583-363 L283-722		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	MOP PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 21

Door(s):
A107

3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	CLASSROOM SECURITY	L9071HD 06A L283-711		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	MOUNTING BRACKET	870SPB		600	ZER
1	EA	SURFACE CLOSER	4040XP SCUSH ST-2648		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 22 - Not Used

HW SET: 23

Door(s):
A108 A109 B140 B141

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	CLASSROOM DEAD LOCK	L463HD XB11-720		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	PUSH PLATE	8200 4" X 16" CFC		630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16" CFC L		630	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	MOP PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
3	EA	SILENCER	SR64/SR65		GRY	IVE

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 24

Door(s):
B114

3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	CLASSROOM LOCK	L9070HD 06A		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
3	EA	SILENCER	SR64/SR65		GRY	IVE

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 25 - Not Used

HW SET: 26

Door(s):

A111 A115

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 27

Door(s):

A112 B120

3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 28

Door(s):

A113

3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	MOUNTING BRACKET	870SPB		600	ZER
1	EA	SURFACE CLOSER	4040XP SCUSH ST-2648		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 29

Door(s):

A118 B144

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 30

Door(s):

A117 A123 A138

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 31

Door(s):

B103 B104.1 B104 B109.1 B106 B107
B109.2 B109

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	PANIC HARDWARE	CDSI-PA-AX-98-L-NL-06		626	VON
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
1	EA	SFIC RIM CYLINDER	80-159 GRN		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	MOUNTING BRACKET	870SPB		600	ZER
1	EA	SURFACE CLOSER	4040XP EDA ST-1754		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

HW SET: 32

Door(s):

B102 B110

6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
2	EA	POWER TRANSFER	EPT10		689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-DT-06		626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-NL-06		626	VON
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
1	EA	SFIC RIM CYLINDER	80-159 GRN		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
2	EA	MOUNTING BRACKET	870SPB		600	ZER
2	EA	SURFACE CLOSER	4040XP EDA ST-1754		689	LCN
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
2	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
2	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP
2	EA	DOOR CONTACT	679-05HM/WD		BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS-FA 900-BBK 120/240 VAC			VON
1			CARD READER - WORK OF DIVISION 28			

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 33

Door(s):

B103.1

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-NL-06	626	VON
1	EA	SFIC RIM CYLINDER	80-159 GRN	626	SCH
1	EA	SFIC EVEREST CORE	**80-037 EV29 R	626	SCH
1	EA	MOUNTING BRACKET	870SPB	600	ZER
1	EA	SURFACE CLOSER	4040XP EDA ST-1754	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
1	SET	GASKETING	570AA-S	AA	ZER
1	EA	DOOR BOTTOM	355AA	AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED	AL	NGP
1	EA	DOOR CONTACT	679-05HM/WD	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS-FA 900-BBK 120/240 VAC		VON
1			CARD READER - WORK OF DIVISION 28		

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 34 - Not Used

HW SET: 35

Door(s):

B135.1

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	CLASSROOM SEC HOLDBK	L9077HD 06A L283-711	626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R	626	SCH
1	EA	MOUNTING BRACKET	870SPB	600	ZER
1	EA	SURFACE CLOSER	4040XP SCUSH ST-2648	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	SET	GASKETING	570AA-S	AA	ZER
1	EA	DOOR BOTTOM	355AA	AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED	AL	NGP

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 36

Door(s):

B109.3

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	CLASSROOM SEC HOLDBK	L9077HD 06A L283-711		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 37 - Not Used

HW SET: 38 - Not Used

HW SET: 39

Door(s):

B135

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 40

Door(s):

B136 B137 B145

3	EA	HINGE	5BB1HW SH 5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	LOCK GUARD	LG1		630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1	SET	GASKETING	429AA-S		AA	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 41

Door(s):

B108.1 B108 B117.1 B117

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	PUSH PLATE	8200 4" X 16"		630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16" L		630	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 42

Door(s):

B128 B146

6	EA	HINGE	5BB1HW SH 5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	SET	AUTO FLUSH BOLT	FB31P/FB41P		630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2		626	IVE
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC 7/8" STRIKE LIP LENGTH		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB/MBF		689	IVE
2	EA	SURFACE CLOSER	4040XP EDA ST-1754		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
2	EA	FLOOR STOP	FS18S/FS18L		BLK	IVE
1	EA	GASKETING	188SBK PSA @ HEADER		BK	ZER
1	SET	GASKETING	328AA-S @ JAMB		AA	ZER
2	EA	DOOR SWEEP	39A		A	ZER
1	EA	ASTRAGAL	44STST		STST	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 43

Door(s):

B133

6	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	SET	AUTO FLUSH BOLT	FB31P/FB41P		630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2		626	IVE
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	COORDINATOR	COR X FL		628	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	SET	ASTRAGAL	140A-S		A	ZER
1	SET	GASKETING	570AA-S		AA	ZER
2	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 44

Door(s):

B139

6	EA	HINGE	5BB1HW SH 4.5 X 4.5 NRP		630	IVE
2	EA	POWER TRANSFER	EPT10		689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
2	EA	ELEC PANIC HARDWARE	RX-LC-PA-AX-98-EO		626	VON
1	EA	MULLION STORAGE KIT	MT54		689	VON
1	EA	ELEC EXIT DEVICE TRIM	*AD-300-993R-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
2	EA	SURFACE CLOSER	4040XP EDA ST-1944		689	LCN
2	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
2	EA	FLOOR STOP	FS18S/FS18L		BLK	IVE
1	SET	GASKETING	429AA-S		AA	ZER
1	EA	MULLION SEAL	8780NBK PSA		BK	ZER
2	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	102A OR AS DETAILED		A	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 45

Door(s):

B105.1 B105

3	EA	HINGE	5BB1HW 5 X 4.5 NRP		652	IVE
1	EA	PANIC HARDWARE	CDSI-PA-AX-98-L-NL-06		626	VON
1	EA	SFIC MORTISE CYL.	80-132 GRN X K510-730 XQ11-948		626	SCH
1	EA	SFIC RIM CYLINDER	80-159 GRN		626	SCH
2	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	MOUNTING BRACKET	870SPB		600	ZER
1	EA	SURFACE CLOSER	4040XP EDA ST-1754		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	GASKETING	570AA-S		AA	ZER
1	EA	DOOR BOTTOM	355AA		AA	ZER
1	EA	THRESHOLD	411 OR AS DETIALED		AL	NGP

HW SET: 46

Door(s):

B127

1	SET	CAM LIFT HINGES	BY ACCOUSTIC DOOR/FRAME MFR			B/O
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	SET	SOUND SEALS	BY ACCOUSTIC DOOR/FRAME MFR.			B/O
1	EA	THRESHOLD	BY ACCOUSTIC DOOR/FRAME MFR.			
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 47

Door(s):

B121 B122

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10		689	VON
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS436/FS438 AS REQ'D		626	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1			POWER SUPPLY - WORK OF DIVISION 28			

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

HW SET: 48

Door(s):

B124

6	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	SET	AUTO FLUSH BOLT	FB31P/FB41P		630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2		626	IVE
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC 7/8" STRIKE LIP LENGTH		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB/MBF		689	IVE
1	EA	SURFACE CLOSER	4040XP EDA ST-1754		689	LCN
1	EA	SURFACE CLOSER	4040XP SCUSH ST-2648		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1	EA	ASTRAGAL	44STST		STST	ZER

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

ARROYO HS – NEW THEATER & ADMINISTRATION BUILDING
EL MONTE, CALIFORNIA
DSA SUBMITTAL
31 MARCH 2024

HW SET: 49

Door(s):

B126 B128.1

6	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	SET	AUTO FLUSH BOLT	FB31P/FB41P		630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2		626	IVE
1	EA	ELEC CLASSROOM LOCK	*AD-300-MS-70-MT-RHO-B 12/24 VDC 7/8" STRIKE LIP LENGTH		626	SCE
1	EA	SFIC EVEREST CORE	**80-037 EV29 R		626	SCH
1	EA	SFIC CONST. CORE	80-035 GRN			SCH
1	EA	COORDINATOR	COR X FL		628	IVE
2	EA	MOUNTING BRACKET	MB/MBF		689	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH ST-2648		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
1	EA	ASTRAGAL	44STST		STST	ZER

* = AD-300 LOCKSET/EXIT DEVICE TRIM LISTED FOR TEMPLATING PURPOSES ONLY. LOCKSET/EXIT DEVICE TRIM SUPPLIED BY DIV. 28.
** = CONSULT DISTRICT FOR KEYING DETAILS

SECTION 08 81 00 - GLASS GLAZING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.
   2. Doors.
   3. Storefront framing.
   4. Glazed curtain walls.
   5. Glazing sealants and accessories.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for sealants, indicating VOC content.

B. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Product Certificates: For glass.

D. Preconstruction adhesion and compatibility test report.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

A. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

B. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.06 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
1. Obtain tinted glass from single source from single manufacturer.
2. Obtain reflective-coated glass from single source from single manufacturer.

B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design exterior glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E1300.
   1. Design Wind Pressures: As indicated on Drawings and in accordance with ASCE 7.
   2. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
   3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
   4. Differential Shading: Design tinted glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
   2. For laminated-glass lites, properties are based on products of construction indicated.
   3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
   5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
   6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. IGMA Publication Insulating Glazing Tolerances: IGMA TB-1200, "Guidelines for Insulating Glass Dimensional Tolerances."
   2. IGMA Publication for Insulating Glass: IGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
   3. IGMA Publication for Thermal Stress: IGMA TM-1500, "Guidelines to Reduce Instances of Thermal Stress."
   4. NGA Publications: "Guidelines for the Appearance of Insulating Glass Unit Edges in Commercial Applications at the Time of Installation."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.04 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

B. Low Iron Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Heat-Strengthened and Fully Tempered Float Glass: ASTM C1048, Kind HS (heat strengthened) and Kind FT (fully tempered), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Bow and Warpage Tolerance: 25 percent less than ASTM C 1048.
   2. Distortion Limits: Calculated using LiteSentry Osprey Distortion + Flatness Inspection System for Glass and Plastic.
      a. Peak-to-Valley Roll Wave:
         1) Peak-to-Valley Distance:
            a) No dimension greater than 0.005 inch, with an average not to exceed 0.003 inch, central area.
            b) No dimension greater than 0.008 inch within 250 mm of the leading and trailing edge.
      b. Optical Roll Wave: For clear and Low iron glass 1/4 inch to 3/8 inch thick without ceramic frit or ink, maximum plus or minus 100 mD (millidiopter) over 95 percent of the glass surface.
   3. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
   4. Kind HS glass greater than 1/4 inch in thickness shall meet strength requirements in accordance with ASTM C 1048.

E. Reflective-Coated Vision Glass (Low-E): ASTM C1376.

2.05 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
   1. Sealing System: Dual seals.
   2. Perimeter Spacer: Provide manufacturer's standard spacer material and construction as required to meet Performance Requirements in Division 08 door, window, and framing assembly sections scheduled to receive insulating glass glazing.
      a. Provide from one of the following:
         1) Aluminum with mill or clear anodic finish.
         2) Stainless steel.
         3) Polypropylene-covered stainless steel in color selected by Architect.
      b. Color: As selected by Architect from manufacturer's full range.
   3. Desiccant: Molecular sieve or silica gel, or blend of both.

2.06 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class as recommended by manufacturer. Use NT.

2.07 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

B. Setting Blocks, Spacers, and Edge Blocks:
1. Type recommended by sealant or glass manufacturer with a Shore A durometer hardness of 85, plus or minus 5.

C. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.01 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.02 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.03 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.04 GLASS GLAZING SCHEDULE

A. GL-11: Low-E-coated, low iron insulating glass.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Minimum Thickness of Each Glass Lite: 6 mm.
3. Outdoor Lite: Low iron heat-strengthened or fully tempered as indicated or required float glass.
    a. Basis-of-Design Product: Vitro; Starfire.
4. Interspace Content: Air.
5. Indoor Lite: Low iron heat-strengthened or fully tempered as indicated or required float glass.
    a. Basis-of-Design Product: Vitro; Starfire.
6. Low-E Coating:
    a. Basis-of-Design Product: Vitro; SolarBan 72.
    b. Location: Sputtered on second surface.

B. GL-21: Ceramic-coated, insulating vision glass.
1. Overall Unit Thickness: 1 inch (25 mm).
2. Minimum Thickness of Each Glass Lite: 6 mm.
3. Outdoor Lite: Low iron, heat-strengthened float glass.
4. Interspace Content: Air.
5. Indoor Lite: Low iron, heat-strengthened float glass.
6. Ceramic Coating :
    a. Coating Location: Fourth surface.

C. GL-31: Monolithic, fully tempered float glass.
1. Glass: Clear float glass.
2. Minimum Thickness: 6 mm.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 08 83 00 - MIRRORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Silvered flat glass mirrors.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 10 28 00 "Toilet Accessories" for metal-framed mirrors.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Mirrors: Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

C. Samples: For each type of the following:
   1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
   2. Mirror Clips: Full size.
   3. Mirror Trim: 12 inches long.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.
   2. Documentation for adhesives, indicating compliance with emissions testing or certification.

B. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.

C. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer, who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.06 PRECONSTRUCTION TESTING

A. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing.
   1. Testing is not required if data are submitted based on previous testing of mirror mastic products and mirror backing matching those submitted.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors in accordance with mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.08 FIELD CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.09 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

A. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

B. Source Limitations for Mirror Accessories: Obtain mirror-glazing accessories from single source.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.03 SILVERED FLAT GLASS MIRRORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Gardner Glass, Inc.
   2. Guardian Glass LLC.
   3. Lenoir Mirror Company.
   4. Trulite Glass & Aluminum Solutions, LLC.
   5. Virginia Mirror Company, Inc.
   6. Walker Glass Co., Ltd.

B. Mirrors, General: ASTM C1503.

C. Annealed Monolithic Glass Mirrors: Mirror Select Quality Q1 clear.
   1. Nominal Thickness: 6.0 mm .

2.04 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

2.05 MIRROR HARDWARE

A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
   1. Aluminum J-Channel Bottom and Side Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Aluminum J-Channel Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
3. Finish: Clear bright anodized.

B. Aluminum J-Channels and Cleat: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
1. Aluminum J-Channel and Cleat, Bottom and Side Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch in height, respectively.
2. Aluminum J-Channel and Cleat, Top Trim: Formed with front leg with a height matching bottom trim and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
3. Finish: Clear bright anodized.

C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

D. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.06 FABRICATION

A. Shop fabricate mirrors to greatest extent possible.

B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts, so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Flat polished .
1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.02 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.03 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced National Glass Association (NGA) publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
   1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
   2. Aluminum J-Channels and Cleat: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
   3. Install mastic as follows:
      a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
      b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
      c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

3.04 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer and NGA's publication "Proper Procedures for Cleaning Flat Glass Mirrors."

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 05 61.13 - MOISTURE VAPOR EMISSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Fluid-applied membrane-forming systems that control the moisture-vapor-emission rate of interior concrete installed as required prior to installation of floor coverings, floor coatings, and other flooring products and systems.

B. Related Sections:
1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
2. Section 07 26 00 "Vapor Retarders" for vapor retarders under concrete slabs-on-grade.
3. Division 09 Sections for flooring system substrate requirements.

1.02 DEFINITIONS

A. MVE: Moisture vapor emission.

B. MVER: Moisture vapor emission rate.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Documentation for coatings, indicating VOC content.
2. Documentation for coatings, indicating compliance with emissions testing or certification.

B. Product Test Reports: For each MVE-control system, for tests performed by a qualified testing agency.

C. Preinstallation testing reports.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

1.07 FIELD CONDITIONS

A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
   1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
   2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
   3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace vapor retarder and floor coverings, floor coatings, and other flooring products and systems that fail due to moisture vapor emission and moisture born contaminates within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Coatings:
      a. VOC content limits for field applications.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.02 PERFORMANCE REQUIREMENTS

A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
1. MVER: Maximum 25 lb of water/1000 sq. ft. when tested according to ASTM F1869.
2. Relative Humidity: Maximum 90 percent when tested according to ASTM F2170 using in situ probes.

B. Water-Vapor Transmission: Through MVE-control system, maximum 0.06 perm when tested according to ASTM E96/E96M.

C. Tensile Bond Strength: For MVE-control system, greater than 200 psi with failure in the concrete according to ASTM D7234.

D. Alkalinity Insensitivity: Insensitivity to alkaline environment up to, and including, pH 14 in a bath test when tested according to ASTM D1308.

2.03 MVE-CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Aquafin Building Product Systems.
2. KOSTER American Corporation.
3. Sika Corporation.
4. Synthetics International.

B. MVE-Control System: ASTM F3010-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
1. Substrate Primer: Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.
2. Cementitious Underlayment Primer: If required for subsequent installation of cementitious underlayment products, provide MVE-control system manufacturer's primer to ensure adhesion of products to MVE-control system.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 ACCESSORIES

A. Patching and Leveling Material: Moisture-, mildew-, and alkali-resistant product recommended in writing by MVE-control system manufacturer and with minimum of 3000-psi compressive strength after 28 days when tested according to ASTM C109/C109M.

B. Crack-Filling Material: Resin-based material recommended in writing by MVE-control system manufacturer for sealing concrete substrate crack repair.

C. Cementitious Underlayment: If required to maintain manufacturer's warranty, provide MVE-control system manufacturer's cement-based underlayment.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Installation of system indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Preinstallation Testing:
1. Testing Agency: Engage a qualified testing agency to perform tests.
2. Alkalinity Testing: Perform pH testing according to ASTM F710. Install MVE-control system in areas where pH readings are less than 7.0 and in areas where pH readings are greater than 8.5.
3. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   a. Anhydrous Calcium Chloride Test: ASTM F1869. Install MVE-control system in locations where concrete substrate MVER exceeds 3 lb of water/1000 sq. ft. in 24 hours.
   b. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.
4. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum 100-sq. ft. area of MVE-control system to prepared concrete substrate and test according to ASTM D7234.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Proceed with installation only where tensile bond strength is greater than 200 psi with failure in the concrete.

B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.
1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
2. Provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
5. Fill surface depressions and irregularities with patching and leveling material.
6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.

C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

3.03 INSTALLATION

A. Install MVE-control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.
1. Install primers as required to comply with manufacturer's written instructions.

B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.

C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.

D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.

F. Install cementitious underlayment over cured membrane if required to maintain manufacturer's warranty and in thickness required to maintain the warranty.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform installation inspections.

B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
1. Verify that surface preparation meets requirements.
2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.

C. MVE-control system will be considered defective if it does not pass inspections.

3.05 PROTECTION

A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.

B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
   2. Suspension systems for interior ceilings and soffits.
   3. Grid suspension systems for gypsum board ceilings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Load Tables: For non-structural metal framing assemblies indicated to comply with performance requirements and design criteria, provide manufacturers' published load tables annotated to show compliance, for each type of framing assembly.

C. Delegated-Design Submittal: For non-structural metal framing assemblies indicated to comply with performance requirements and design criteria not otherwise addressed in manufacturers' published load tables, provide analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Shop Drawings:
   1. Include layout, spacings, sizes, thicknesses, and types of non-structural metal framing; fabrication; and fastening and anchorage details.
   2. Indicate framed openings, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.03 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. CEMCO; California Expanded Metal Products Co.
   2. ClarkDietrich Building Systems.
   3. SCAFCO Steel Stud Company.
   4. Steel Network, Inc. (The).

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 PERFORMANCE REQUIREMENTS

A. Design framing systems in accordance with American Iron and Steel Institute Publication AISI S220, except as otherwise shown or specified.

B. Performance: Provide non-structural metal framing assemblies capable of withstanding design loads within limits and under conditions indicated.
   1. Design Load: 5 lbf/sq. ft. uniform air-pressure differential acting perpendicular to covering material supported by metal framing.
   2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
      a. Walls Scheduled for Brittle Finishes Including Ceramic Tile: Horizontal deflection greater than 1/360 of the wall height, and as recommended by wall finish manufacturer.
      b. All Other Wall Assemblies: Horizontal deflection greater than 1/240 of the wall height.
      c. Ceiling Assemblies and Suspension Systems: Vertical deflection greater than 1/240.

C. Design framed openings to withstand design loads, gravity loads, and construction tolerances with a maximum deflection not to exceed that recommended by manufacturer of product or system in opening.

D. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

E. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.03 FRAMING SYSTEMS

A. Thickness: Where metal thickness is indicated, it is a minimum. Provide framing members in thicknesses as needed to comply with requirements indicated.

B. Framing Members, General: Comply with ASTM C754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
   2. Protective Coating: ASTM A653/A653M, G40 , hot-dip galvanized unless otherwise indicated.

C. Studs and Tracks: ASTM C645.
   1. Steel Studs and Tracks:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection .
b. Depth: As indicated on Drawings.

D. Deflection System: Where indicated, provide one of the following:
1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing minimum vertical movement indicated.
2. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
3. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Steel Thickness: As indicated on Drawings .

F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.
1. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

G. Z-Shaped Clips: With slotted or nonslotted web, face flange, minimum uncoated-steel thickness of 0.034 inch, and depth required to fit insulation thickness indicated.

2.04 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
2. Steel Studs and Tracks: ASTM C645.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.05 GRID SUSPENSION SYSTEMS

A. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Armstrong World Industries, Inc.; "Drywall Grid Systems."
      b. Rockfon, LLC; Chicago Metallic "Drywall Grid System."
      c. USG Corporation; "Drywall Suspension System."
   2. Structural Classification: Heavy-duty system.

2.06 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Masonry or Concrete Walls: Provide one of the following:
   1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
   2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.03 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
1. Deflection System Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.05 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 24 00 - PORTLAND CEMENT PLASTERING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Exterior portland cement plaster (stucco).

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.

C. Samples : For each type of factory-prepared finish coat indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, tests performed by a qualified testing agency.

1.04 QUALITY ASSURANCE

A. Mockups: Before plastering, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 PROJECT CONDITIONS

A. Comply with ASTM C 926 requirements.

B. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Zinc Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G60 zinc coating.

B. Extruded Aluminum: ASTM B 221, alloy type 6063 T5.
   1. Finish:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
b. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.

2.02 METAL LATH

A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
1. Diamond-Mesh Lath: Self-furring, 3.4 lb/sq. yd..
2. Flat Rib Lath: Rib depth of not more than 1/8 inch, 3.4 lb/sq. yd..
3. 3/8-Inch Rib Lath: 3.4 lb/sq. yd..

B. Paper Backing: FS UU-B-790, Type I, Grade D, Style 2 vapor-permeable paper.
1. Provide paper-backed lath at exterior locations.

2.03 ACCESSORIES

A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Metal Accessories:
1. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 zinc coating.
2. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
3. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
4. Cornerbeads: Fabricated from extruded aluminum or zinc-coated (galvanized) steel.
5. Casing Beads: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
6. Control Joints: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
7. Expansion Joints: Fabricated from extruded aluminum or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
8. Two-Piece Expansion Joints: Fabricated from extruded aluminum orzinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch wide; with perforated flanges.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 MISCELLANEOUS MATERIALS

A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in portland cement plaster.

C. Bonding Compound: ASTM C 932.

D. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.

E. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.

F. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter, unless otherwise indicated.

2.05 PLASTER MATERIALS

A. Portland Cement: ASTM C 150, Type I.
1. Color for Finish Coats: Gray.

B. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.

C. Sand Aggregate: ASTM C 897.

D. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. California Stucco Products Corp.; Texture Flex.
b. Dryvit Systems, Inc.; Dryvit TAFS.
c. El Rey Stucco Company, Inc., a brand of ParexLaHabra, Inc.; Prema-Flex.
d. Finestone, BASF Wall Systems, Inc.; PebbleTex.
e. LaHabra, a brand of ParexLaHabra, Inc.; Acrylic Finish.
f. Master Wall Inc.; Superior Finishes.
g. Omega Products International, Inc.; Omega Flex Finishes.
h. Parex, Inc., a brand of ParexLaHabra, Inc.; e-lastic.
i. Pleko Group LLC Products, Inc.; Pleko Structure Finishes.
j. Senergy, BASF Wall Systems, Inc.; Senerflex.
k. Shamrock Stucco LLC; Stucco Acrylic Finish.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

l. Sto Corp.; Powerwall Finish.
m. Stuc-O-Flex International, Inc.; Elastomeric Finish
n. Surewall, a brand of ParexLaHabra, Inc.; Acrylic Finish.
o. SonoWall, BASF Wall Systems, Inc.; StuccoTex Finish.

2. Color and Texture: As indicated on drawings.

2.06 PLASTER MIXES

A. General: Comply with ASTM C 926 for applications indicated.
1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials.

B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
1. Portland Cement Mixes:
a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.

C. Factory-Prepared Finish-Coat Mixes: For acrylic-based finish coatings, comply with manufacturer's written instructions.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

B. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

3.02 INSTALLING METAL LATH

A. Expanded-Metal Lath: Install according to ASTM C 1063.
1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
2. Flat-Ceiling and Horizontal Framing: Install 3/8-inch rib lath lath.

3.03 INSTALLING ACCESSORIES

A. Install according to ASTM C 1063 and at locations indicated on Drawings.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Reinforcement for External Corners:
1. Install lath-type, external-corner reinforcement at exterior locations.
2. Install cornerbead at exterior locations.

C. Control Joints: Install control joints at locations indicated on Drawings.
1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
a. Vertical Surfaces: 144 sq. ft..
b. Horizontal and other Nonvertical Surfaces: 100 sq. ft..
2. At distances between control joints of not greater than 18 feet o.c.
3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
4. Where control joints occur in surface of construction directly behind plaster.
5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.04 PLASTER APPLICATION

A. General: Comply with ASTM C 926.

B. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 3/4-inch thickness.
1. Portland cement mixes.

C. Ceilings; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 1/2 inch thick.
1. Portland cement mixes.
2. Masonry cement mixes.
3. Portland and masonry cement mixes.
4. Plastic cement mixes.
5. Portland and plastic cement mixes.

D. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.

E. Concealed Exterior Plasterwork: Where plaster application will be used as a base for adhered finishes, omit finish coat.

3.05 PLASTER REPAIRS

A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 06 16 43 "Gypsum Sheathing" for gypsum sheathing for exterior applications.
   3. Section 07 92 00 "Joint Sealants" for acoustical sealants installed as part of STC-rated gypsum board assemblies.
   4. Section 09 30 00 "Tiling" for backer units installed as substrates for tile.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.

1.04 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.05 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Continental Building Products.
5. National Gypsum Company.
6. PABCO Gypsum.
7. USG Corporation.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Adhesives:
a. VOC content limits for field applications.

2.03 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.04 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.
1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

2.05 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Expansion (control) joint.
g. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Fry Reglet Corp.
b. Gordon, Inc.
c. Pittcon Industries.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
3. Finish: As selected by Architect from manufacturer's full range.

2.06 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:
1. Interior Gypsum Board: Paper.
2. Glass-Mat-Faced Gypsum Board: 10-by-10 glass mesh.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purposecompound.
a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.

2.07 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
   1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

D. Sound Attenuation Blankets: As specified in Division 09 Section "Acoustic Insulation."

E. Acoustical Joint Sealant: As specified in Division 07 Section "Sealants."

F. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.03 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
1. Type X: As indicated on Drawings.
2. Ceiling Type: As indicated on Drawings.

B. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) or horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.04 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners unless otherwise indicated.
2. Bullnose Bead: Use where indicated.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use where indicated.
6. Curved-Edge Cornerbead: Use at curved openings.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.05 INSTALLATION OF PARTITION CLOSURES

A. General: Attach end wall cap extrusions to framing with same fasteners used for gypsum panels. Install partition closure assemblies according to manufacturer's written instructions.

3.06 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 4: Surfaces scheduled for light-textured finishes, wallcoverings, flat paints and panel surfaces that will be exposed to view, unless otherwise indicated .

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Primer and its application to surfaces are specified in other Division 09 Sections.

3. Level 5: Surfaces scheduled for gloss and semigloss coatings, wall and ceiling areas abutting window mullions or skylights, curved surfaces, long hallways, large surface areas flooded with artificial and/or natural lighting and where indicated on Drawings.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.

E. Curved Surfaces: In accordance with GA-226.

3.07 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 30 00 - TILING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Ceramic tile.
2. Glass tile.
3. Tile backing panels.
4. Waterproof membrane.
5. Crack isolation membrane.
6. Sound isolation membrane.
7. Metal edge strips.

B. Related Sections:
1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
2. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Verification:
1. Full-size units of each type of trim and accessory for each color and finish required.
2. Metal edge strips in 6-inch lengths.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Documentation for sealers, indicating VOC content.
2. Documentation for sealers, indicating compliance with emissions testing or certification.
3. Environmental Product Declarations: For products that comply with environmental product declarations.
4. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 QUALITY ASSURANCE

A. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

1.05 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.06 WARRANTY

A. Special Waterproofing Warranty: Manufacturer agrees to replace waterproofing that does not comply with material requirements within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers for Setting and Grouting Materials:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ARDEX Americas.
      b. Custom Building Products.
      c. H.B. Fuller Construction Products Inc. / TEC.
      d. Laticrete International, Inc.
      e. MAPEI Corporation.
      f. Parex USA, Inc.

B. Source Limitations for Setting and Grouting Materials: Obtain setting and grouting materials from single manufacturer and aggregate from single source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
   1. Stone thresholds.
   2. Waterproof membrane.
   3. Crack isolation membrane.
   4. Sound isolation membrane.
   5. Backer units.
   6. Metal edge strips.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Sealers:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.03 PERFORMANCE REQUIREMENTS

A. Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products in accordance with:
   1. Level Surfaces Not Subject To Wetting: SCOF of not less than 0.50 in accordance with ANSI A1264.2, Section E11.2.
   2. Level Surfaces Subject To Wetting: DCOF of not less than 0.42 in accordance with ANSI A137.1.

2.04 CERAMIC TILE PRODUCTS

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. Ceramic Tile: Vitreous or impervious natural clay or porcelain; 1/4 inch thick, unless otherwise indicated. As scheduled on Drawings:
   1. Sustainable Design Criteria:
      a. Environmental Product Declaration.
      b. Material Health Disclosure.
   2. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as indicated on Drawings .

2.05 GLASS TILE PRODUCTS

A. ANSI Glass Tile Standard: Provide Standard grade glass tile that complies with ANSI A137.2 for types and other characteristics indicated.

B. Glass Tile: Cast, fused, or low temperature coated; 1/4 inch thick, unless otherwise indicated. As scheduled on drawings.

2.06 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. CertainTeed Corporation; GlasRoc Tile Backer.
b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
c. National Gypsum Company; eXP Tile Backer.
d. USG Corporation; Durock Glass-Mat Tile Backerboard.

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.07 WATERPROOF MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with fabric reinforcement facing; 0.040-inch nominal thickness.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. National Applied Construction Products, Inc.; Strataflex.
b. Protecto Wrap; AFM-WM.

2.08 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Bostik, Inc; Hydroment GoldPlus.
b. Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
c. H.B. Fuller Construction Products Inc. / TEC; HydraFlex - Waterproofing Crack Isolation Membrane.
d. Laticrete International, Inc.; Laticrete Hydro Ban.
e. MAPEI Corporation; Mapelastic CI.

2.09 SOUND ISOLATION MEMBRANE

A. General: Manufacturer's standard product and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
1. Basis-of-Design Product:
a. Laticrete; 170.3 Sound & Crack Isolation Mat.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.10 SETTING MATERIALS

A. Improved Modified Dry-Set Mortar (Thinset): ANSI A118.15.
   1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
   3. For glass tile applications, provide white mortar.

B. Modified Dry-Set Mortar for Large and Heavy Tile (Medium-Bed): Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
   1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
   3. For glass tile applications, provide white mortar.

C. Improved Modified Dry-Set Mortar for Large and Heavy Tile (Medium-Bed): Comply with requirements in ANSI A118.15. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
   1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
   3. For glass tile applications, provide white mortar.

D. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3.
   1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.11 GROUT MATERIALS

A. Grout Colors: As selected by Architect from manufacturers full range.

B. High-Performance Tile Grout: ANSI A118.7.
   1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

C. Water-Cleanable Epoxy Grout: ANSI A118.3.
   1. Sustainable Design Criteria:
      a. Material Health Disclosure.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.12 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Profile as indicated, height to match tile and setting-bed thickness, designed specifically for tiling applications.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Blanke Corporation.
      b. Ceramic Tool Company, Inc.
      c. Schluter Systems L.P.
   2. Exposed Finish: As selected by Architect from manufacturer's full range.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

D. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Custom Building Products; Grout and Tile Sealer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with bonded mortar bed comply with surface finish requirements in ANSI A108.01 for installations indicated.
      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with dry-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 INSTALLATION OF TILE BACKING PANEL

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.04 INSTALLATION OF WATERPROOF MEMBRANE

A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.05 INSTALLATION OF CRACK ISOLATION MEMBRANE

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.06 INSTALLATION OF SOUND ISOLATION MEMBRANE

A. Install sound isolation membrane to comply with manufacturer's written instructions to produce membrane installation that is bonded securely to substrate.

3.07 TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
      a. Tile floors in wet areas.
      b. Tile floors consisting of tiles 8 by 8 inches or larger.
   2. For the following installations, provide 100 percent mortar coverage:
      a. Glass tile.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Joint Widths: Unless otherwise indicated, install tile with joint widths as recommended by tile manufacturer.

E. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
   2. Locate expansion joints as recommended by tile and tile installation material manufacturers, but not less than the following:
      a. Interior Locations: 20-25 feet in each direction.
      b. Interior Locations at Above Ground Concrete Slabs: 8-12 feet in each direction.
      c. Interior Locations Exposed to Direct Sunlight or Moisture: 8-12 feet in each direction.
      d. Exterior Locations: 8-12 feet in each direction.
      e. Perimeter joints.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Metal Edge Strips: Install at locations indicated .

G. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to sealer manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.08 CLEANING AND PROTECTION

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all tile surfaces so they are free of foreign matter.
   1. Remove grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

C. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

E. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.09 INTERIOR TILE INSTALLATION SCHEDULE

A. Interior Floor Installations:
   1. Ceramic Tile Over Concrete:
      a. TCNA F112: On-ground and above-ground concrete; Cured mortar bed; ANSI A108.1B.
         1) Membrane: Waterproof membrane.
         2) Mortar: Improved modified dry-set mortar.
            a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
         3) Grout: Standard cement grout, sanded or unsanded as recommended by tile manufacturer.
      b. TCNA F113, F113A: On-ground and above-ground concrete.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1) Membrane: Crack-isolation membrane, in accordance with installation method TCNA F125-Full.
2) Mortar: Improved modified dry-set mortar.
   a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
3) Grout: Standard cement grout, sanded or unsanded as recommended by tile manufacturer.

c. TCNA F125-Full: On-ground and above-ground concrete; Crack isolation membrane.
   1) Use with tile types that are 6 by 6 inches or larger, in conjunction with corresponding installation method.

d. TCNA F205, 205A: On-ground and above-ground concrete; Cementitious self-leveling underlayment.
   1) Use in locations requiring self-leveling underlayment, in conjunction with corresponding installation method.

B. Interior Wall Installations:
   1. Ceramic Tile Over Wood or Metal Studs:
      a. TCNA W245: Wood or metal studs; Coated glass-mat, water-resistant gypsum backer board.
         1) Membrane: Waterproof membrane.
         2) Mortar: Improved modified dry-set mortar.
            a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
         3) Grout: Standard cement grout, sanded or unsanded as recommended by tile manufacturer.
   2. Glass Tile Over Wood or Metal Studs:
      a. TCNA W245: Wood or metal studs; Coated glass-mat, water-resistant gypsum backer board.
         1) Membrane: Fluid-applied crack isolation membrane when recommended by tile manufacturer.
         2) Mortar: Improved modified dry-set mortar.
            a) Provide thinset mortar unless medium-bed mortar is recommended by tile or mortar manufacturer.
         3) Grout: Standard cement grout, sanded or unsanded as recommended by tile manufacturer.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Acoustical panels and exposed suspension systems for interior ceilings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
   1. Acoustical Panels: Set of 6-inch- square Samples of each type, color, pattern, and texture.
   2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for ceiling products, indicating compliance with emissions testing or certification.
   2. Environmental Product Declarations: For products that comply with environmental product declarations.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Ceiling suspension-system members.
   2. Structural members to which suspension systems will be attached.
   3. Method of attaching hangers to building structure.
      a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
   4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
   5. Size and location of initial access modules for acoustical panels.
   6. Items penetrating finished ceiling and ceiling-mounted items including the following:
      a. Lighting fixtures.
      b. Diffusers.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

c. Grilles.
d. Speakers.
e. Sprinklers.
f. Access panels.
g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated or comparable product by one of the following:
1. Armstrong World Industries, Inc.
2. CertainTeed Corporation.
3. Rockfon (Rockwool International).
4. USG Corporation.

B. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Ceiling Products:
   a. VOC emissions testing or certification.

2.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Class A according to ASTM E1264.
   2. Smoke-Developed Index: 50 or less.

2.04 ACOUSTICAL PANELS

A. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264.

B. Basis-of-Design Product: As indicated on Drawings.
   1. Sustainable Design Criteria:
      a. Environmental Product Declaration.

2.05 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
   1. Structural Classification: Heavy-duty system, unless noted otherwise.

B. Metal Suspension System:
   1. Basis-of-Design Product: As indicated on Drawings.

2.06 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:
   1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
   2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.

F. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

I. Seismic Perimeter Retention System:
   1. Seismic Wall Molding: 2-inch molding.
   2. Seismic Perimeter Clips: Manufacturer's standard clips designed to accommodate seismic forces.
      a. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
         1) Armstrong World Industries, Inc; BERC Series.
         2) USG Corporation; ACM7 Seismic Clip.
      b. Molding Profile: Manufacturer's standard 7/8-inch-wide profile, as selected by Architect.

2.07 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
   1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
   2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
   1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
   2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.08 ACOUSTICAL SEALANT

A. Acoustical Sealant: As specified in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.03 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C636/C636M, seismic design requirements, and manufacturer's written instructions.
   1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. Arrange directionally patterned acoustical panels as follows:
a. As indicated on reflected ceiling plans.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
7. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.04 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 64 56 - RESILIENT STAGE FLOORING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Furnishing and installing a new stage floor as specified and as indicated on Drawings for the auditorium stage.

B. Installation work includes, but is not limited to the following:
1. Verification of dimensions and conditions at the job site.
2. Installation of new sheet vapor retardant on substrate surface, neoprene pads, shimmed sleepers, plywood sub-flooring, finish flooring, door sills, wall base, and apron edge nosings in accordance with these Specifications, related Drawings, established trade criteria, and all applicable code requirements.

C. Related work:
1. The above scope of work is intended as a reference guide only and is not intended to define the limits of the work necessary for a complete installation. All labor, materials, and equipment necessary for the proper operation of all systems must be provided.

D. Bids must include:
1. All equipment specified or indicated in the ‘Products’ section and in the related drawing documents, including all the necessary hardware, fittings, and components necessary for a complete and functional stage floor.
2. Schedule and time estimate for preparation, fabrication, equipment delivery, and installation.

1.02 SUBMITTALS

A. Make submittals in accordance with Section 013300.
1. Submit product data for moisture barrier, resilient blocks, insulation, floor materials, and floor coating.
2. Submit a 1’-0” x 1’-0” sample of flooring including proposed assembly of subflooring, resilient neoprene pads, edge blocking on one side, and floor finish color on surface.
3. Shop Drawings: For each type of floor assembly and accessory. Include plans, elevations, sections, details, and attachments to other work. Include expansion provisions and trim details.

1.03 QUALITY ASSURANCE

A. The entire stage floor shall be installed by a single Contractor including moisture barrier, flooring, anchorage system, acoustical batting, sub-flooring, resilient mounts, trim, sleepers, expansion provisions, and finish.

B. All flooring must be obtained from a single manufacturer or source to ensure the match of color, texture, pattern, and quality.

C. Floor shall be slip-resistant per CBC 11B-302.1.

D. The contractor shall be specialized in the installation of resilient flooring with not less than 5 years of experience in the installation of stage flooring.

1.04 WARRANTY

A. Contractor shall provide Owner with copies of a 3-year warranty for finished wood flooring and associated work. This warranty shall agree to repair or replace flooring that shrinks, warps, cracks, or otherwise deteriorates excessively, or that buckles, delaminates, or breaks its anchorage or bond with substrate or otherwise fails to perform as required or as represented by the manufacturer due to failures of materials and workmanship. Warranty shall be signed by the Contractor who shall assume the responsibility for obtaining warranties on materials from manufacturers.

PART 2 - PRODUCTS

2.01 FINISH PANEL FLOORING

A. Plyron, exterior grade, 3/4 inch thick, tempered both sides.

2.02 SUB-FLOORING

A. One layer of A-C Douglas Fir plywood, exterior glue, 3/4 inch thick.

2.03 SLEEPERS

A. Douglas Fir 2x4s. Kiln-dried to 15% maximum moisture content. Discard bowed or twisted pieces.

2.04 CUSHION BLOCKS

A. 3/4” thick neoprene resilient pads, approximately 2” x 2” square, hardness of 45-50 durometer.

2.05 DOORWAY TRANSITIONS

A. Provide solid wood blocking for the stage floor at doorway transitions. Do not use resilient rubber pads at doorways. Provide wood blocking only for the width of doorway or at floor material floor transitions (i.e. wood stage floor to concrete.)

2.06 ACCESSORIES

A. Sheet Vapor Retardant: 6 mil thick black polyethylene, with 2-inch wide self-adhesive, reinforced tape for lap joint sealing.

B. Wall Base: Vinyl, 4-inch high with a 3-inch toe, ventilating type, with attachment accessories, pre-fabricated corner intersections, black color.

C. Insulation: Provide semi-rigid glass fiber insulation panels, 1-1/2 inch thick, unfaced.

2.07 FINISHING

A. Finish: Water-based, acrylic theatrical primer.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Tough-Prime by Rosco Laboratories or approved comparable product.
   2. Color: No. 06055 Black.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, HANDLING, AND PREPARATION

A. Protect wood flooring from excessive moisture in shipment, storage, and handling. Deliver in unopened packaging fully identified to show type, brand, grade, and quality.

B. Place wood flooring materials in space to be floored at least 7 days in advance of start of installation. Open packages of wood flooring that are sealed to permit natural adjustment of moisture content.

C. Maintain minimum room temperature 65 degrees F, maximum 78 degrees F, for a period of 2 days prior to delivery of materials, during, and after installation.

D. Verify that recessed subfloor surface is smooth and flat to a tolerance of 1/8 inch per 10 feet.

E. Verify that concrete substrate moisture content is 8 percent maximum.

F. Do not install wood flooring until wet construction work is completed and building is completely weatherproofed.

3.02 EXAMINATION

A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.

B. Examine hardboard panels before installation. Reject panels that have damaged corners or edges, or are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. General:
   1. Comply with flooring manufacturer's recommendations and approved submittals. Maintain 1-1/4"inch clear separation at all perimeters and penetrations.

B. Concrete Slabs: Grind high spots and fill low spots to produce a maximum 1/8-inch (3-mm) deviation in any direction when checked with a 10-foot (3-m) straight edge.
   1. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

C. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Install moisture barrier wherever flooring will be installed on concrete.

E. Thresholds: Provide solid blocking in place of resilient pads at thresholds so that floor remains level with adjacent floor and does not depress at thresholds unless a threshold is shown of different construction in the drawings.

F. Provide neoprene pads for optimum floor resiliency. Space nominally 16 inches on center in upstage to downstage direction and 16 inches on center in onstage to offstage direction. Ensure that pads rest on wood sleepers before attachment. Attach neoprene pads to lower side of sleeper using epoxy cement.

G. Place sleepers around the perimeter of the stage. Place balance of the sleepers in parallel rows on 16" centers across the stage area. Lay sleepers in upstage/downstage direction.

H. Attach plywood subfloor layers to the sleepers with flat head wood screws on 16" centers leaving 1/4" space at plywood joints. Lap seams between layers 16" in both directions.

I. Apply Plyron flooring with flat head wood screws on 16" centers around perimeter and centerline of each 4' x 8' sheet. Countersink all screw heads. Leave 3/32" space at all joints. Use no adhesives. Lay 8-foot panels in a stage left to stage right pattern.

J. Plyron seam joints should align with the centerline of the proscenium opening and with the plaster line of the proscenium opening

3.04 FINISHING

A. Allow installed stage floor to acclimate to ambient conditions for a minimum period of 10 days before finishing.

B. Do not sand hardboard finish.

C. Apply two coats of Rosco Tough Prime Black sealer/paint to edges of hardboard finish flooring in accordance with manufacturer's instructions.

D. Apply Rosco Tough Prime Black to clean, dry surface. Apply by brush or roller. Apply in even, uniform coats using overlapping strokes, change roller direction often to avoid patterns and streaking. Do not apply heavy coat. Apply in a minimum of 3 thin coats, allowing each to dry thoroughly dry between applications. Apply per manufacturer's instructions. Rosco Tough Prime is final finished surface. Do not buff or sand.

E. Do not cover wood flooring after finishing until finish reaches full cure.

F. Do not apply plastic coatings of any type. Final finish shall be dark and low luster.

3.05 COMPLETION

A. Install base and shoe moldings.

B. Install extruded, mill finished 1/4-inch thick by width and length required beveled edge aluminum thresholds where necessary.

3.06 CLEANING AND PROTECTION

A. Prior to final acceptance, repair any flooring defects and remove any stains that have penetrated the new finish.

B. Protect completed flooring during construction period with heavy kraft paper or other suitable covering to prevent damage to or deterioration of flooring and finish until final facility acceptance. Do not use plastic sheet or film that could cause condensation.

END OF SECTION

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Resilient tile flooring.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 09 65 13 "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of resilient flooring.
   1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
   2. Show details of special patterns.

C. Samples for Verification: For each type of resilient flooring, in manufacturer's standard size, but not less than 6-by-9-inch sections of each color, texture, and pattern required.

D. Product Schedule: For resilient flooring. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives , indicating VOC content.
   2. Documentation for adhesives , indicating compliance with emissions testing or certification.
   3. Documentation for flooring products, indicating compliance with emissions testing or certification.

B. Product Test Reports:
   1. Slip-resistance test reports from qualified independent testing agency.

C. Qualification Data: For Installer.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of resilient flooring to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient flooring installation and seaming method indicated.
   1. Engage an installer who employs workers for this Project who are trained or certified by resilient flooring manufacturer for installation techniques required.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient flooring during the following periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Close spaces to traffic during resilient flooring installation.

D. Close spaces to traffic for 48 hours after resilient flooring installation.

E. Install resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. VOC content limits for field applications.
b. VOC emissions testing or certification for field applications within the weatherproofing system.

2. Flooring Products:
a. VOC emissions testing or certification.

2.02 PERFORMANCE REQUIREMENTS

A. Slip Resistance, Coefficient of Friction: Provide flooring with the following values as determined by testing identical products in accordance with the following:
1. Level Surfaces, Dry and Wet: DCOF of not less than 0.42 in accordance with ANSI A326.3.

B. Fire-Test-Response Characteristics: For resilient flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.03 RESILIENT TILE FLOORING

A. Vinyl Composition Floor Tile (VCT):
1. Basis-of-Design Product: As indicated on Drawings.
2. Colors and Patterns: As indicated by manufacturer's designations on Drawings. .

2.04 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient flooring and substrate conditions indicated.

C. High Performance Adhesives: Type recommended by manufacturer where heavy static or rolling loads exist.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient flooring manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient flooring.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Prepare substrates according to resilient flooring manufacturer's written instructions to ensure adhesion of resilient flooring.

B. Concrete Substrates: Prepare according to ASTM F710.
1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient flooring until materials are the same temperature as space where they are to be installed.
1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient flooring.

3.03 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.04 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient flooring.

B. Perform the following operations immediately after completing resilient flooring installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.

E. Cover resilient flooring until Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Resilient base.
   2. Resilient accessories.
   3. Resilient molding accessories.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.
   2. Documentation for adhesives, indicating compliance with emissions testing or certification.
   3. Documentation for resilient base, indicating compliance with emissions testing or certification.
   4. Environmental Product Declarations: For products that comply with environmental product declarations.
   5. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.05 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.
   2. Resilient Base:
      a. VOC emissions testing or certification.

2.02 RESILIENT BASE

A. Basis-of-Design Product: As indicated on Drawings.
      a. Sustainable Design Criteria:
         1) Environmental Product Declaration.
         2) Material Health Disclosure.

B. Product Standard: One of the following:
   1. ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
   2. ASTM F1861, Type TP (rubber, thermoplastic).

C. Thickness: 0.125 inch.

D. Height: As indicated on Drawings.

E. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Outside Corners: Job formed or preformed.

G. Inside Corners: Job formed or preformed.

H. Colors: As indicated by manufacturer's designations .

2.03 STAIR ACCESSORIES

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Stair Treads: ASTM F2169.
1. Type: Type TV (vinyl, thermoplastic).
2. Class: 1 (smooth, flat).
3. Group: 2 (with contrasting color for the visually impaired).
4. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees.
5. Nosing Height: As indicated on drawings.
6. Thickness: 1/4 inch and tapered to back edge.
7. Size: Lengths and depths to fit each stair tread in one piece.

C. Locations: Provide rubber stair accessories in areas indicated.

D. Colors and Patterns: As indicated by manufacturer's designations.

2.04 MOLDING ACCESSORIES

A. Description: Provide rubber or vinyl molding accessories as follows:
1. As indicated on drawings.

B. Profile and Dimensions: As indicated.

C. Colors and Patterns: As indicated by manufacturer's designations.

2.05 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
   1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
a. Miter or cope corners to minimize open joints.

3.04 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:
1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Modular carpet tile.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 09 65 13 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
   2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, plans showing the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
   2. Carpet tile type, color, and dye lot.
   3. Type of subfloor.
   4. Type of installation.
   5. Pattern of installation.
   6. Pattern type, location, and direction.
   7. Pile direction.
   8. Type, color, and location of insets and borders.
   9. Type, color, and location of edge, transition, and other accessory strips.
   10. Transition details to other flooring materials.

C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.
   2. Documentation for adhesives, indicating compliance with emissions testing or certification.
   3. Documentation for flooring products, indicating compliance with emissions testing or certification.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

4. Environmental Product Declarations: For products that comply with environmental product declarations.
5. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

B. Qualification Data: For Installer.

C. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

D. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Carpet and Rug Institute's CRI 104.

1.07 FIELD CONDITIONS

A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.08 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, the following:
      a. More than 10 percent edge raveling, snags, and runs.
      b. Dimensional instability.
      c. Excess static discharge.
      d. Loss of tuft-bind strength.
      e. Loss of face fiber.
      f. Delamination.
   3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.
   2. Flooring Products:
      a. VOC emissions testing or certification.

2.02 CARPET TILE

A. Products: As indicated on drawings.
   1. Sustainable Design Criteria:
      a. Environmental Product Declaration.
      b. Material Health Disclosure.

B. Performance Characteristics:
   1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
   2. Optical Smoke Density Rating: Does not exceed 450 according to ASTM E662.
   3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
   1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
      a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
      b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
      c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.02 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.03 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

3.04 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 72 00 - WALL COVERINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Wood-veneer wall covering.
   2. Wallpaper.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.

B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement and veneer matching seams and termination points.

C. Samples for Verification: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36 inches long in size.
   1. Wall-Covering Sample: From same production run to be used for the Work, with specified treatments applied.
      a. Show complete pattern repeat.
      b. Mark top and face of fabric.
   2. Wood-Veneer Wall-Covering Sample: From same flitch to be used for the Work, with specified finish applied.

D. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.
   2. Documentation for adhesives, indicating compliance with emissions testing or certification.
   3. Environmental Product Declarations: For products that comply with environmental product declarations.
   4. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

B. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.
   1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F1141 for appearance shading characteristics.
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.
   1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.

B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 50 or less.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Fire-Growth Contribution: No flashover and heat and smoke release when tested in accordance with NFPA 265.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Adhesives:
a. VOC content limits for field applications.
b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.03 WOOD-VENEER WALL COVERING

A. Basis-of-Design Product: As indicated on Drawings:
1. Sustainable Design Criteria:
a. Environmental Product Declaration.

B. Description: Provide wood-veneer wall covering in rolls from same production run.

C. Wood Species: As indicated on drawings.

D. Finish: Factory applied using wall-covering manufacturer's standard stain and polyurethane system.
1. Colors: As selected by Architect from manufacturer's full range.

2.04 WALLPAPER

A. Description: Provide wallpaper in rolls from same production run.
1. Basis-of-Design Product: As indicated on Drawings.
a. Sustainable Design Criteria:
1) Material Health Disclosure.
2. Category: II, Decorative with Medium Serviceability.

B. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range.

2.05 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

B. Primer/Sealer: Mildew resistant, complying with requirements in Section 09 91 00 "Painting" and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
   2. Plaster: Allow plaster to cure for at least 90 days. Neutralize areas of high alkalinity. Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
   3. Metals: If not factory primed, clean and apply metal primer as recommended in writing by metal-primer manufacturer and wall-covering manufacturer.
   4. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
   5. Painted Surfaces:
      a. Check for pigment bleeding. Apply primer/sealer to areas susceptible to pigment bleeding as recommended in writing by primer/sealer manufacturer.
      b. Sand gloss, semigloss, and eggshell finishes with fine sandpaper.

D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.03 INSTALLATION OF WALL COVERING

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.
   1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Match pattern 72 inches above the finish floor.

F. Install seams vertical and plumb at least 6 inches from outside corners and 6 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.04 CLEANING

A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 81 00 - ACOUSTIC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Acoustic blanket insulation.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.
   2. Documentation for insulation, indicating compliance with emissions testing or certification.

1.04 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.
   2. Insulation:
      a. VOC emissions testing or certification.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 PERFORMANCE REQUIREMENTS

A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.03 ACOUSTIC INSULATION

A. Acoustic Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins free of added urea formaldehyde with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Thickness:
      a. Partitions: As required to fill cavity.
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Partitions:
         1) Johns Manville; Unfaced Fiberglass Batts.
         2) Owens Corning; Pink Next Gen Sound Attenuation Batts.
      b. Above Suspended Ceilings:
         1) Johns Manville; Unfaced Fiberglass Batts.
         2) Owens Corning; Pink Next Gen Sound Attenuation Batts.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness.

E. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by attaching flanges of insulation to flanges of studs.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 84 33 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sound-absorbing wall panels.
   2. Sound-diffusing and -reflecting wall panels.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.
   2. Section 09 72 00 "Wall Coverings" for adhesively applied textile wall coverings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include fabric facing, panel edge, core material, and mounting indicated.

B. Shop Drawings: For unit assembly and installation.
   1. Include plans, elevations, sections, and mounting devices and details.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for adhesives, indicating VOC content.
   2. Documentation for adhesives, indicating compliance with emissions testing or certification.
   3. Documentation for wall products, indicating compliance with emissions testing or certification.

B. Product Certificates: For each type of unit.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.

C. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Adhesives:
      a. VOC content limits for field applications.
      b. VOC emissions testing or certification for field applications within the weatherproofing system.
   2. Wall Products:
      a. VOC emissions testing or certification.

2.02 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Units to comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested in accordance with NFPA 265 Method B Protocol or NFPA 286.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 SOUND-ABSORBING WALL UNITS

A. Sound-Absorbing Wall Panels: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Acoustical Panel Systems (APS, Inc.).
      b. Acoustical Solutions.
      c. Armstrong World Industries, Inc.
      d. Conwed.
      e. Decoustics; CertainTeed Architectural Products; a Saint Gobain company.
      f. G&S Acoustics.
      g. Kinetics Noise Control, Inc.
      h. Lamvin, Inc.
      i. MBI Products Company, Inc.
      j. Sound Concepts.
      k. Wenger Corporation.
   2. Panel Shape: As indicated on Drawings.
   3. Mounting:
      a. Back mounted with manufacturer's standard metal clips or bar hangers, secured to substrate.
   4. Core: Manufacturer's standard.
   5. Edge Construction: Manufacturer's standard.
   6. Corner Detail in Elevation: Square with continuous edge profile indicated.
   7. Reveals between Panels: Flush reveals as indicated on Drawings.
   8. Facing Material: As indicated on Drawings.
   9. Nominal Overall Panel Thickness: As indicated on Drawings.
   10. Panel Width: As indicated on Drawings.
   11. Panel Height: As indicated on Drawings.

2.04 SOUND-DIFFUSING AND -REFLECTING WALL UNITS

A. Sound-Diffusing and -Reflecting Wall Panels: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Lamvin; Sonic Geometric Diffusers and Sonic Reflective Panels or comparable product by one of the following:
      a. Acoustical Panel Systems (APS, Inc.).
      b. Acoustical Solutions.
      c. Armstrong World Industries, Inc.
      d. Conwed.
      e. Decoustics; CertainTeed Architectural Products; a Saint Gobain company.
      f. G&S Acoustics.
      g. Kinetics Noise Control, Inc.
      h. MBI Products Company, Inc.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

i. Sound Concepts.
j. Wenger Corporation.

2. Panel Shape: As indicated on Drawings.
3. Mounting: Back mounted with manufacturer's standard impaling clips or metal clips or bar hangers, secured to substrate.
4. Core: Manufacturer's standard, prepared for required acoustical performance.
5. Edge Construction: Manufacturer's standard.
6. Reveals between Panels: Flush reveals As indicated on Drawings.
7. Facing Material: As indicated on Drawings.
8. Panel Width: As indicated on Drawings.
9. Panel Height: As indicated on Drawings.

2.05 MATERIALS

A. Core Materials: Manufacturer's standard.

B. Facing Material : Fabric from same dye lot; color and pattern as selected by Architect from manufacturer's full range and as indicated on Drawings.

C. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:
1. Impaling Clips: Manufacturer's standard.
2. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.06 FABRICATION

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

C. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.02 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align fabric pattern and grain with adjacent units.

3.03 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches, noncumulative.

B. Variation of Joint Width: Not more than 1/16-inch variation from [**hairline**][**reveal line**] in 48 inches, noncumulative.

3.04 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials in accordance with manufacturer's written instructions.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 84 36 - SOUND-ABSORBING CEILING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
   1. Sound-absorbing baffle panels.
   2. Sound-diffusing ceiling panels.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include panel edge, core material, and mounting indicated.

B. Shop Drawings: For unit assembly and installation.
   1. Include reflected ceiling plans, elevations, sections, and mounting devices and details.
   2. Include details at joints and corners; and details at ceiling intersections and intersections with walls. Indicate panel edge profile and core materials.
   3. Include direction of fabric weave and pattern matching.

C. Samples for Initial Selection: For each type of fabric facing.
   1. Include Samples of hardware and accessories involving color or finish selection.

D. Samples for Verification: For the following products:
   1. Fabric: Full-width by approximately 36-inch- long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for ceiling unit products, indicating compliance with emissions testing or certification.
   2. Documentation for composite wood products, indicating compliance with emissions testing or certification.
   3. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturer's written cleaning and stain-removal instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.

C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Ceiling Unit Products:
      a. VOC emissions testing or certification.

2.02 PERFORMANCE REQUIREMENTS

A. Seismic Criteria: Provide suspended sound-absorbing ceiling units designed and installed to withstand the effects of earthquake motions in accordance with ASCE/SEI 7 and requirements of authorities having jurisdiction.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.

2.03 SOUND-ABSORBING CEILING UNITS

A. Sound-Absorbing Baffle Panel: Manufacturer's standard panel construction.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
   2. Sustainable Design Criteria:
      a. Material Health Disclosure.
   3. Panel Shape: As indicated on Drawings.
   4. Mounting: Top-edge mounted with manufacturer's standard suspension system , secured to substrate.
   5. Core: Manufacturer's standard .
   6. Nominal Overall Panel Thickness: As indicated on Drawings.
   7. Panel Width: As indicated on Drawings.
   8. Panel Height: As indicated on Drawings.

2.04 SOUND-DIFFUSING CEILING UNITS

A. Sound-Diffusing Ceiling Panel: Manufacturer's standard panel construction.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Wenger Corporation; Traditional Acoustical Panel Series Diffuser Panels, or comparable product by one of the following:
      a. Armstrong Ceiling & Wall Solutions.
      b. Conwed.
      c. Lamvin, Inc.
      d. Sound Concepts.
      e. Turf Design, Inc.
   2. Panel Shape: Pyramidal.
   3. Mounting: Back mounted with manufacturer's standard suspension system, secured to substrate.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.05 FABRICATION

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated, with facing material applied to face, edges, and back border of dimensionally stable core and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Measure each area and establish layout of panels and joints of sizes indicated on Drawings within a given area.

C. Edge Hardening: For glass-fiber board and mineral-fiber board cores, chemically harden core edges and areas of core where mounting devices are attached.

D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with edges in alignment with walls and other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.03 INSTALLATION TOLERANCES

A. Variation from Alignment with Surfaces: Plus or minus 1/16 inch in 48 inches, noncumulative.

B. Variation from Level or Slope: Plus or minus 1/16 inch.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.04 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 09 91 00 - PAINTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Surface preparation and the application of paint systems on interior and exterior substrates.

B. Related Sections:
1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 DEFINITIONS

A. Sheen Levels:
1. Flat: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
2. Eggshell: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
3. Satin: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
4. Semi-Gloss: 35 to 70 units at 60 degrees, according to ASTM D523.
5. Gloss: 70 units and greater at 60 degrees, according to ASTM D523.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.04 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Documentation for paints and coatings, indicating VOC content.
2. Documentation for paints and coatings, indicating compliance with emissions testing or certification.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3. Environmental Product Declarations: For products that comply with environmental product declarations.
4. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

1.05 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in other Part 3 articles for the paint category indicated.

B. Source Limitations: Obtain products for each coating system from single source from single manufacturer.

2.02 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
1. Paints and Coatings:
a. VOC content limits for field applications.
b. VOC emissions testing or certification for field applications within the weatherproofing system.

2.03 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. Colors: As indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
2. Fiber-Cement Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Wood: 15 percent.
5. Gypsum Board: 12 percent.
6. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

D. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

G. Galvanized-Metal Substrates:
1. Metal Substrates Galvanized in Accordance with ASTM A 123 and ASTM A 153: Prepare substrates in accordance with ASTM D 6386.
2. Other Galvanized Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Wood Substrates:
1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.03 INSTALLATION

A. Apply paints according to manufacturer's written instructions.
1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in equipment rooms:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Tanks that do not have factory-applied final finishes.
      h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   2. Paint the following work where exposed in occupied spaces:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      h. Other items as directed by Architect.
   3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.04 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
   2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.05 CLEANING AND PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 INTERIOR PAINTING SCHEDULE

A. Gypsum Board; Acrylic Latex: Provide one of the following systems:
   1. Benjamin Moore:
      a. Primer: Ultra Spec 500 Interior Latex Primer.
      b. Intermediate Coat: Same as top coat.
      c. Top Coat: Ultra Spec 500 Interior.
      d. Sheen:
         1) Walls: Eggshell, unless indicated otherwise.
         2) Ceilings: Flat, unless indicated otherwise.
   2. Sherwin Williams:
      a. Primer: ProMar 200 Zero VOC Interior Latex Primer B28 Series.
      b. Intermediate Coat: Same as top coat.
      c. Top Coat: ProMar 200 Zero VOC Interior Latex.
      d. Sheen:
         1) Walls: Eggshell, unless indicated otherwise.
         2) Ceilings: Flat, unless indicated otherwise.
   3. PPG:
      a. Primer: Speedhide ZERO VOC Interior Latex Primer.
      b. Intermediate Coat: Same as top coat.
      c. Top Coat: Speedhide ZERO VOC Interior Latex.
         1) Sustainable Design Criteria:
            a) Environmental Product Declaration.
            b) Material Health Disclosure.
      d. Sheen:
         1) Walls: Eggshell, unless indicated otherwise.
         2) Ceilings: Flat, unless indicated otherwise.

B. Ferrous and Non Ferrous Metals Including: Exposed metal fabrications, steel doors, steel door frames, grilles, panels, stairs, railings, and other miscellaneous metal items indicated; Direct to Metal Acrylic. Provide one of the following systems:
   1. Rustoleum Sierra Performance:
      a. Primer: S-37 System Metalmax DTM Acrylic Urethane.
      b. Intermediate Coat: None required.
      c. Top Coat: Same as Primer.
      d. Sheen: Semi-gloss, unless indicated otherwise.
   2. Sherwin Williams:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Primer: Pro Industrial ProCryl Primer B66-1300.
b. Intermediate Coat: None required.
c. Top Coat: Pro Industrial Acrylic B66-1151 Series.
d. Sheen: Semi-gloss, unless indicated otherwise.

3. PPG:
a. Primer: Pitt-Tech Plus EP PRIMER Int/Ext Rust Inhibitive Primer.
b. Intermediate Coat: None required.
c. Top Coat: 90-1610 Pitt-Tech Plus EP DTM Light Industrial.
d. Sheen: Semi-gloss, unless indicated otherwise.

C. Mechanical And Electric Equipment Items: Insulated Piping Galvanized Ducts, Piping, Conduits, etc.; Ferrous Piping, Hangers (and like items);Electric Panels; and as indicated. Provide one of the following systems:
1. Tnemec:
a. One Coat: Uni-Bond DF Series 115; 3.0 DFM.
b. Color: White.
2. PPG:
a. One Coat: Speedhide Super Tech Interior Dry Fog Flat 6-723XI.
b. Color: White.

3.07 EXTERIOR PAINTING SCHEDULE

A. Ferrous Metal: Exposed steel members, bollards, exposed miscellaneous metal; Urethane. Provide the following system:
1. Tnemec:
a. Primer: Zinc-rich polyurethane; Tneme-Zinc 90G-1K97, 2.5 to 3.5 DFM.
b. Intermediate Coat: Polyamidoamine epoxy; Series L69 Hi-Build Epoxoline II, 4 to 6 DFM.
c. Top Coat: Aliphatic Acrylic Polyurethane; Series 1095 Endura-Shield, 2 to 5 DFM.
d. Sheen: Semi-gloss.

B. Galvanized Metal: Exposed structural steel members, hollow metal doors and frames, railings, bollards, canopy framing, exposed miscellaneous metal; Urethane. Provide the following system:
1. Tnemec:
a. Primer: Polyamidoamine epoxy, Series L69, 4 to 6 DFM.
b. Intermediate Coat: Not required.
c. Top Coat: Aliphatic Acrylic Polyurethane; Series 1095 Endura-Shield; 2 to 5 DFM.
d. Sheen: Semi-gloss.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 12 00 - DISPLAY CASES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Illuminated display cases.

1.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Display cases shall withstand the effects of earthquake motions according to ASCE/SEI 7.

B. Sustainable Design Performance Requirements:
   1. Composite wood products shall comply with the following:
      a. Testing and product requirements of the California Department of Health Services CDPH Standard Method v1.1.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For display cases. Include plans, elevations, sections, details, and attachments to other work.
   1. Show location of seams and joints in visual display surfaces.
   2. Include sections of typical trim members.
   3. Wiring Diagrams: For power, signal, and control wiring.

C. Sustainable Design Submittals:
   1. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

D. Samples: For each exposed product and for each color and texture specified.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

F. Maintenance Data: For visual display surfaces, operating hardware, and illuminated units to include in maintenance manuals.

1.04 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Hardboard: ANSI A135.4, tempered.

B. Particleboard: ANSI A208.1, Grade M-1.

C. Fiberboard: ASTM C 208.

D. Hardwood Plywood: HPVA HP-1.

E. Extruded-Aluminum Bars and Shapes: ASTM B 221, Alloy 6063.

F. Aluminum Tubing: ASTM B 429, Alloy 6063.

G. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering, and 6 mm thick unless otherwise indicated.

H. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished), colorless sheet with visible light transmittance of 92 percent measured per ASTM D 1003.

I. Opaque Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet).

J. Translucent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished). Provide white-colored sheet unless otherwise indicated, of density required to produce uniform brightness and minimum halation effects.

K. High-Pressure Plastic Laminate: NEMA LD 3.

L. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 DISPLAY CASE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. A-1 Visual Systems.
2. AARCO Products, Inc.
3. ADP Lemco, Inc.
4. Best-Rite Manufacturing.
5. Claridge Products and Equipment, Inc.
6. Ghent Manufacturing, Inc.
7. Nelson-Harkins Industries.
8. Platinum Visual Systems; a division of ABC School Equipment, Inc.
9. Poblocki Sign Company.
10. PolyVision Corporation; a Steelcase company.
11. Tablet & Ticket Co. (The).

B. Illumination System: Concealed top-lighting system consisting of fluorescent-strip fixtures. Include lamps and internal wiring with single concealed electrical connection to building system. Coordinate electrical characteristics with power supply provided.

2.03 FABRICATION

A. Fabricate display cases to requirements indicated for dimensions, design, and thickness and finish of materials.

B. Use metals and shapes of thickness and reinforcing to produce flat surfaces, free of oil-canning, and to impart strength for size, design, and application indicated.

C. Fabricate cabinets and door frames with reinforced corners, mitered to a hairline fit, with no exposed fasteners.

D. Fabricate shelf standards plumb and at heights to align shelf brackets for level shelves.

2.04 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install units in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Recessed Display Cases: Attach units to wall framing with fasteners at not more than 16 inches o.c. Attach aluminum trim over edges of recessed display cases and conceal grounds and clips. Attach trim with fasteners at not more than 24 inches o.c.

C. Surface-Mounted Display Cases: Attach units to wall surfaces with concealed clips, hangers, or grounds fastened at not more than 16 inches o.c. Secure both top and bottom of display cases to walls.

D. Install display case shelving level and straight.

E. Adjust doors to operate smoothly without warp or bind and so contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Panel signs.
   2. Metal plaques.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
   3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign.

C. Samples: For each exposed product and for each color and texture specified.

D. Product Schedule: For signs. Use same designations indicated on Drawings or specified.

1.03 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.05 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and California Building Code, Chapter 11.

2.02 PANEL SIGNS

A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ACE Sign Systems, Inc.
      b. Advance Corporation.
      c. Allen Industries Architectural Signage.
      d. Allen Markings.
      e. APCO Graphics, Inc.
      f. ASE, Inc.
      g. ASI Sign Systems, Inc.
      h. Best Sign Systems, Inc.
      i. Bunting Graphics, Inc.
      j. Clarke Systems.
      k. Cosco.
      l. Diskey Architectural Signage Inc.
      m. Fossil Industries, Inc.
      n. Inpro Corporation.
      o. Mohawk Sign Systems.
      p. Nelson-Harkins Industries.
      q. Poblocki Sign Company, LLC.
      r. Seton Identification Products; a Brady Corporation company.
      s. Signs & Decal Corp.
      t. Stamprite Supersine; a division of Stamp Rite Inc.
      u. Vista System.
      v. Vomar Products, Inc.
   2. Sign Material: As indicated on Drawings .
      a. Surface-Applied, Flat Graphics: Applied baked enamel or powder coat.
      b. Surface-Applied, Raised Graphics: Applied polymer characters andBraille.
      c. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
      d. Engraved Graphics: Characters engraved through plastic-laminate face sheet to expose contrasting phenolic core.
   3. Sign-Panel Perimeter: Finish edges smooth.
      a. Edge Condition: As indicated on Drawings.
      b. Corner Condition in Elevation: As indicated on Drawings .
   4. Mounting: As indicated on Drawings or manufacturer's standard method for substrates indicated where not indicated, with concealed anchors.
   5. Surface Finish and Applied Graphics:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color as selected by Architect from manufacturer's full range.
b. Painted Finish and Graphics: Manufacturer's standard, factory-applied acrylic polyurethane, in color as selected by Architect from manufacturer's full range.

2.03 METAL PLAQUES

A. Cast Plaque: Cast-metal plaque with background texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. A.R.K. Ramos.
b. ACE Sign Systems, Inc.
c. Erie Landmark Company; a division of Paul W. Zimmerman Foundaries, Inc.
d. Gemini Signage; Gemini, Inc.
e. Matthews International Corporation; Bronze Division.
f. Metallic Arts.
g. Signs & Decal Corp.
h. Southwell Company (The).
2. Plaque Material: Cast aluminum.
3. Plaque Thickness: As indicated on drawings.
4. Finishes:
a. Integral Metal Finish: As selected by Architect from full range of industry finishes.
b. Overcoat: Manufacturer's standard baked-on clear coating.
5. Background Texture: As selected by Architect from manufacturer's full range.
6. Integrally Cast Border Style: As indicated on Drawings .
7. Mounting: As indicated on Drawings .
8. Text and Typeface: Typeface as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color.

2.04 SIGN MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Acrylic Sheet: ASTM D4802, Type UVF (UV filtering).

E. Polycarbonate Sheet: Coated, mar-resistant, UV-stabilized polycarbonate, with coating on both sides.

F. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

2.05 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
   3. Exposed Metal-Fastener Components, General:
      a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   4. Sign Mounting Fasteners:
      a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.

2.06 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
   1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
   2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
   3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
   4. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
   1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Install signs so they do not protrude or obstruct according to the accessibility standard.
   3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
   4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Accessible Signage: Install in locations on walls as indicated on Drawings .

C. Mounting Methods:
   1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
      a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
      b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

D. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 14 19 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Dimensional characters.

1.02 COORDINATION

A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
   3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.

C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
   1. Dimensional Characters: Full-size Sample of each type of dimensional character.

D. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.04 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Failures include, but are not limited to, the following:
   a. Deterioration of finishes beyond normal weathering.
   b. Separation or delamination of sheet materials and components.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 DIMENSIONAL CHARACTERS

A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. A.R.K. Ramos.
      b. ACE Sign Systems, Inc.
      c. ASI Sign Systems, Inc.
      d. Cosco.
      e. Gemini Signage; Gemini, Inc.
      f. Matthews International Corporation; Bronze Division.
      g. Metal Arts.
      h. Metallic Arts.
      i. Southwell Company (The).
   2. Character Material: Cast aluminum.
   3. Character Height: As indicated on Drawings.
   4. Thickness: As indicated on Drawings.
   5. Finishes:
      a. Integral Aluminum Finish: Anodized color as selected by Architect from full range of industry colors and color densities.
      b. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color as selected by Architect from manufacturer's full range.
      c. Overcoat: Manufacturer's standard baked-on clear coating.
   6. Mounting: As indicated on Drawings .

B. Cutout Characters: Characters with uniform faces; square-cut, smooth, eased edges; precisely formed lines and profiles; and as follows:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. A.R.K. Ramos.
      b. ACE Sign Systems, Inc.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

c. APCO Graphics, Inc.
d. ASI Sign Systems, Inc.
e. Cosco.
f. Diskey Sign Company.
g. Matthews International Corporation; Bronze Division.
h. Metal Arts.
i. Metallic Arts.
j. Southwell Company (The).
k. Steel Art Company.
l. inpro Corporation.

2. Character Material: Sheet or plate aluminum .
3. Character Height: As indicated on Drawings.
4. Thickness: As indicated on Drawings or manufacturer's standard for size of character where not indicated.
5. Finishes:
   a. Integral Aluminum Finish: Anodized color as selected by Architect from full range of industry colors and color densities.
   b. Overcoat: Manufacturer's standard baked-on clear coating.
6. Mounting: As indicated on Drawings .

2.03 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.04 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish nonferrous-metal, stainless steel, or hot-dip galvanized devices unless otherwise indicated.
   3. Exposed Metal-Fastener Components, General:
      a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
      b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant Allen-head or one-way-head slots unless otherwise indicated.
   4. Sign Mounting Fasteners:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

2.05 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

2.06 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.07 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

B. Color Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that electrical service is correctly sized and located to accommodate signs.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF DIMENSIONAL CHARACTERS

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
   1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
   3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.

3.03 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Toilet compartments configured as toilet enclosures and urinal screens of the following type:
      a. Reinforced solid composite.

B. Related Sections:
   1. Section 10 28 13 "Toilet Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings: For toilet compartments.
   1. Include plans, elevations, sections, and attachment details.
   2. Show locations of cutouts for compartment-mounted toilet accessories.
   3. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
   4. Show locations of centerlines of toilet fixtures.
   5. Show locations of floor drains.

C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
   1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch- square Samples of same thickness and material indicated for Work.
   2. Each type of hardware and accessory.

1.03 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.04 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and California Building Code for toilet compartments designated as accessible.

B. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

2.02 SOLID COLOR REINFORCED COMPOSITE TOILET COMPARMENTS

A. Manufacturers: Subject to compliance with requirements, provide the following:
1. Sierra Series; Bobrick Washroom Equipment Co., Inc.

B. Toilet-Enclosure Style: Floor anchored.

C. Urinal-Screen Style: Wall hung.

D. Door, Panel, and Pilaster Construction: Solid color reinforced composite panel material with clear melamine facing on both sides fused to substrate, and with eased and polished edges. Provide minimum 3/4-inch- thick doors and pilasters and minimum 1/2-inch- thick panels.

E. Pilaster Shoes and Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.

F. Brackets (Fittings):
1. Stirrup Type: Ear or U-brackets, stainless steel.
2. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2.03 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.
1. Hinges: Manufacturer's minimum 0.062-inch- thick, stainless steel continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door. Mount with through-bolts.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
3. Coat Hook: Manufacturer's heavy-duty, combination cast stainless steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast stainless steel bumper at out-swinging doors. Mount with through-bolts.
5. Door Pull: Manufacturer's heavy-duty cast stainless steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.04 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: ASTM B221.

C. Stainless Steel Castings: ASTM A743/A743M.

D. Zamac: ASTM B86, commercial zinc-alloy die castings, chrome plated.

2.05 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories, and solid blocking within panel where required for attachment of toilet accessories.

B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
   1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Coordinate layout and installation of supports, inserts, and anchors built into other units of work for toilet compartment anchorage.

3.02 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position indicated with manufacturer's recommended anchoring devices.
   1. Maximum Clearances:
      a. Pilasters and Panels: 1/2 inch.
      b. Panels and Walls: 1 inch.
   2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached near top and bottom of panel.
      a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
      b. Align brackets at pilasters with brackets at walls.
   3. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
      a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
      b. Align brackets at pilasters with brackets at walls.

B. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.03 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 22 39.13 - FOLDING GLASS-PANEL PARTITIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Manually operated, glass-panel partitions.

B. Related Sections:
   1. Section 05 50 00 "Metal Fabrications" for supports that attach supporting tracks to overhead structural system.

1.02 DEFINITIONS

A. STC: Sound Transmission Class.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For operable glass-panel partitions.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.

C. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:
   1. Panel Edge Material: Not less than 3 inches long.
   2. Glass: Units 12 inches square.
   3. Hardware: One of each exposed door-operating device.

1.04 INFORMATIONAL SUBMITTALS

A. Design Data Submittal: For operable glass-panel partitions.
   1. Include design calculations for seismic restraints that brace tracks to structure above.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Partition track, track supports and bracing, switches, turning space, and storage layout.
   2. Suspended ceiling components.
   3. Structural members to which suspension systems are attached.
   4. Size and location of initial access modules for acoustical tile.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.

D. Sample Warranty: For manufacturer's special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For operable glass-panel partitions to include in maintenance manuals.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of operable glass-panel partitions that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of operable glass-panel partitions.
      b. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Operable glass-panel partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."

B. Acoustical Performance: Provide operable glass-panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
   1. Sound-Transmission Requirements: Operable glass-panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.

C. Fire-Test-Response Characteristics: Provide wood-framed panels complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 OPERABLE GLASS PANELS

A. Operable Glass Panels: Frameless aluminum glass-panel partition system, including panels, [**seals,**]suspension system, operators, and accessories.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide NanaWall PrivaSEE Frameless Opening Glass Wall or a comparable product by one of the following:
      a. Avanti Systems USA.
      b. KWIK-WALL Company.
      c. Modernfold.
      d. Solar Innovations, Inc.

B. Panel Operation: Manually operated, individual panels.

C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
   1. Factory-Glazed Fabrication: Glaze operable glass panels in the factory where practical and possible for applications indicated. Comply with manufacturer's written instructions and with requirements in Section 08 81 00 "Glass Glazing."

D. Glass and Glazing: As follows:
   1. Safety Glass Standard for Partition Panels: Glass products complying with testing requirements in 16 CFR 1201, Category II, or ANSI Z97.1, Class A.
   2. Safety Glass Standard for Pass Doors: Glass products complying with testing requirements in 16 CFR 1201, Category II.
   3. Glass: Manufacturer's standard safety glass and glass assemblies as indicated and complying with requirements in Section 08 81 00 "Glass Glazing" and as follows:
      a. Tempered Glass: ASTM C1048, Kind FT (fully tempered), Type I (transparent flat glass), Class 1 (clear), Quality-Q3.
      b. Glass Thickness: Manufacturer's standard thickness for indicated requirements.
      c. Glass Vertical Edge: Manufacturer's standard, permanently adhered edge trim.
   4. Glazing System: Manufacturer's standard factory-glazing system that produces acoustical seal.

E. Dimensions: Fabricate operable glass-panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
   1. Panel Width: As indicated.

F. STC: Not less than 36.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

G. Panel Frame Materials:
1. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B221 for extrusions; manufacturer's standard strengths and thicknesses for type of use.

H. Panel Closure: Manufacturer's standard unless otherwise indicated.

I. Hardware: Manufacturer's standard as required to operate operable glass-panel partition and accessories; with decorative, protective finish.
1. Hinges: Manufacturer's standard.

J. Panel Frame Finishes:
1. Exposed Metal: As selected by Architect from manufacturer's full range as follows:
a. Aluminum: Clear anodized.

2.03 SEALS

A. Description: Seals that produce operable glass-panel partitions complying with performance requirements and the following:
1. Manufacturer's standard seals unless otherwise indicated.
2. Seals made from materials and in profiles that minimize sound leakage.
3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable glass-panel partition perimeter and adjacent surfaces, when operable glass-panel partition is extended and closed.

2.04 SUSPENSION SYSTEMS

A. Tracks: Steel or aluminum mounted directly to overhead structural support, or with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable glass-panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable glass-panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
1. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.

B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

2.05 ACCESSORIES

A. Vertical Edge Trim: Manufacturer's standard transparent trim to protect vertical edges of glass in frameless panels.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable glass-panel partitions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install operable glass-panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.

B. Install panels in numbered sequence indicated on Shop Drawings.

C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

E. Light-Leakage Test: Temporarily opacify glass areas of panels. Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals.

3.03 ADJUSTING

A. Adjust operable glass-panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 28 00 - TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Washroom accessories.

1.02 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify accessories using designations indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.05 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.06 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, visible silver spoilage defects.
   2. Warranty Period: 10 years from date of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design accessories and fasteners to comply with the following requirements:
   1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2.02 WASHROOM ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on drawings or comparable products by one of the following:
   1. AJW Architectural Products.
   2. ASI-American Specialties, Inc.
   3. Bobrick Washroom Equipment, Inc.
   4. Bradley Corporation.
   5. Brey-Krause Manufacturing Co.
   6. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.
   7. Tubular Specialties Manufacturing, Inc.

2.03 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to comply with specified structural-performance requirements.

C. Shower Seats: Install to comply with specified structural-performance requirements.

3.02 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 51 13 - METAL LOCKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Knocked-down corridor lockers.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each color specified.

1.03 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and California Building Code, Chapter 11.

2.02 KNOCKED-DOWN CORRIDOR LOCKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Lyon Workspace; 53123 - Five Tier Metal Lockers or comparable product by one of the following:
   1. AJW Architectural Products.
   2. Art Metal Products.
   3. ASI Storage Solutions; ASI Group.
   4. General Storage Systems Ltd.
   5. Hadrian Manufacturing Inc.
   6. List Industries Inc.
   7. Lyon Workspace Products, LLC.
   8. Olympus Lockers & Storage Products, Inc.
   9. Penco Products, Inc.
   10. Republic Storage Systems, LLC.
   11. Shanahan's Manufacturing Limited.
   12. Top Tier Storage Products.
   13. WEC Manufacturing LLC.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Doors: One piece; fabricated from 0.060-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
   1. Doors less than 12 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
   2. Doors for box lockers less than 15 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
   3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
   4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch nominal-thickness steel sheet; welded to inner face of doors.
   5. Door Style: Vented panel as follows:
      a. Louvered Vents: No fewer than three louver openings at top and bottom for double-tierlockers.

C. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
   1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch nominal thickness, with single bend at sides.
   2. Backs and Sides: 0.024-inch nominal thickness, with full-height, double-flanged connections.

D. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

E. Hinges:
   1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches high. Provide no fewer than three hinges for each door more than 42 inches high.

F. Door Handle and Latch for Box Lockers: Stainless steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.
   1. Provide lock and key type for ADA accessible lockers per 11B-309.4.

G. Continuous Zee Base: Fabricated from 0.060-inch nominal-thickness steel sheet.
   1. Height: 4 inches.

H. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.

I. Filler Panels: Fabricated from 0.036-inch nominal-thickness steel sheet.

J. Boxed End Panels: Fabricated from 0.060-inch nominal-thickness steel sheet.

K. Materials:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

L. Finish: Baked enamel or powder coat.
1. Color: Dove Gray.

2.03 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Knocked-Down Construction: Fabricate metal lockers by assembling at Project site, using manufacturer's nuts, bolts, screws, or rivets.

D. Accessible Lockers: Fabricate as follows:
1. Locate bottom shelf no lower than 15 inches above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.

E. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.

F. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.

G. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

H. Boxed End Panels: Fabricated with 1-inch- wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.
1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
3. Anchor back-to-back metal lockers to floor.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Knocked-Down Lockers: Assemble with manufacturer's standard fasteners, with no exposed fasteners on door faces or face frames.

C. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
   1. Attach recess trim to recessed metal lockers with concealed clips.
   2. Attach filler panels with concealed fasteners.
   3. Attach sloping-top units to metal lockers, with closures at exposed ends.
   4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 81 13 - BIRD CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bird control deterrent system.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, details of typical sections and connections. Provide location and details of anchorage devices to be embedded in or fastened to other construction. Furnish templates if required for accurate placement.
   1. Include diagrams for power, signal, and control wiring.

C. Installer certificates.

D. Maintenance data.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is acceptable to bird control device manufacturer to install manufacturer's products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Source Limitations: Obtain components from a single manufacturer.

PART 2 - PRODUCTS

2.01 BIRD DETERRENT ELECTRIC SHOCK TRACK

A. Generall: Bird deterrent electric shock system comprised of individual components including track, wire, chargers, connectors, and accessories that when put together create a humane and discreet deterrent for birds.

B. Basis-of-Design System: Subject to compliance with requirements, provide Nixalite; Bird-Zap Shock Track Systemor comparable product by one of the following:
   1. D&S Specialty Products Inc.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Bird-Zap Track: Flexible, UV resistant PVC strip with 2 stainless steel conductors sewn into the track.
   1. Color: As selected by Architect.

D. Solar Powered Chargers: High voltage, low amperage, low impedance DC power chargers.

2.02 MOUNTING ACCESSORIES

A. Adhesive: As recommended by manufacturer and compatible with substrate and items being adhered.

B. Fasteners: Stainless-steel, self-drilling sheet metal screws, bolts, and other fasteners compatible with items being fastened.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Inspect substrates and conditions under which the work of this section will be performed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Install bird deterrent systems at locations and in position indicated, securely attached to substrates and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with manufacturer's written instructions.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 11 12 33.21 SWING ARM BARRIER GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Manual swing arm barrier gates.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for swinging barrier gate assemblies.

B. Shop Drawings:
   1. Include plans, elevations, sections and attachment details.
   2. Include details of gate assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1.03 INFORMATIONAL SUBMITTALS

A. Design Data Submittal: For structural performance of gate assemblies, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For swinging barrier gates to include in emergency, operation, and maintenance manuals.

1.05 FIELD CONDITIONS

A. Field Measurements: Verify layout information for gates shown on Drawings. Verify dimensions by field measurements.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of gates that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure to comply with performance requirements.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Five years from date of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance:
1. Gate assemblies shall withstand the design wind loads and stresses for gates under exposure conditions indicated according to ASCE/SEI 7.
a. Design Wind Load: As indicated on Drawings.
2. Gate assemblies shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
a. Gate Arms:
1) Uniform load of 150 lbf/ ft. applied in any direction.
2) Concentrated load of 500 lbf applied in any direction.
3) Uniform and concentrated loads need not be assumed to act concurrently.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 MANUAL SWING ARM BARRIER GATES

A. General: Provide manual swing arm barrier gate assemblies consisting of gate supports, hinges, gate locks, and gate arms and other components and accessories required for a complete assembly.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Commercial Door Company.
b. Pisor Fence, Inc.

B. Gate Assembly: ASTM F900 for gate posts and double swing gate types.
1. Gate Leaf Width: As indicated on drawings.

C. Galvanized-Steel Pipe and Tubing: Fabricate swing arms from tubes in sizes indicated on drawings and as required to meet performance requirements indicated, formed from 0.108-inch nominal-thickness minimum metallic-coated steel sheet or formed from 0.105-inch nominal-thickness minimum steel sheet and hot-dip galvanized after fabrication.
1. Gate Posts: As indicated on drawings .
2. Gate Arms: As indicated on drawings .

D. Gate Arm Corner Construction: Welded.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

F. Hinges: Manufacturer's standard swing arm gate hinges suitable for exterior use.
1. Material: Hot-dip galvanized steel.

G. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.

H. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good-quality, uniform undressed weld with minimal splatter.

I. Anchor Bolts and Fasteners: Galvanized.
1. Hot-dip galvanized according to ASTM A153/A153M and ASTM F2329/F2329M.

2.03 GATE MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

C. Iron Castings: Either gray or malleable iron unless otherwise indicated.
1. Gray Iron: ASTM A48/A48M, Class 30.
2. Malleable Iron: ASTM A47/A47M.

D. Galvanizing: For components indicated to be galvanized and for which galvanized coating is unspecified, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

2.04 MISCELLANEOUS MATERIALS

A. Gate Hardware:
1. Provide center gate stops for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

2.05 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form exposed work with accurate angles and surfaces and straight edges.

D. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

2.06 FINISHES

A. Coating System: Apply primers and topcoats that comply with Section 09 91 00 "Painting."

PART 3 - EXECUTION

3.01 INSTALLATION OF SWING ARM BARRIER GATES

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

C. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

3.02 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate gates, gate hardware and other moving parts.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 11 61 23 - STAGE EXTENSON PLATFORMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Orchestra pit fillers to match height of stage platform as shown on project drawings.

1.02 REFERENCES

A. American Hardboard Association (AHA):
   1. AHA A135.4-95: Basic Hardboard.

B. ASTM International (ASTM):
   1. ASTM B 209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM B 221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. ASTM B 429: Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

C. National Association of Architectural Metal Manufacturers (NAAMM):
   1. Metal Finishes Manual for Architectural and Metal Products, 1988.

D. NFPA International (NFPA):
   1. NFPA 701: Fire Tests for Flame-Resistant Textiles and Films.

E. U.S. Department of Commerce, National Institute of Standards and Technology:
   1. DOC PS 1: U.S. Product Standard for Construction and Industrial Plywood.

F. US Green Building Council (USGBC):
   1. Leadership in Energy and Environmental Design (LEED) Green Building Rating System.

1.03 SYSTEM DESCRIPTION

A. Portable, interlocking platform system with interchangeable, adjustable columns cross braced to independently supported platform, with individually removable acoustically-isolated honeycomb panels.

1.04 PERFORMANCE REQUIREMENTS

A. Structural Performance, Orchestra Pit Filler
   1. Uniform Live Load: 125 lbf/sq. ft. (6 kN/sq. m).
   2. Point Load: No permanent deformation from 500 lb (227 kg) load on 2-inch (50 mm) diameter rubber wheeled caster.
   3. Deflection: Not exceeding L/360 at design live load for 72 inch (1829 mm) long panel and span.

B. Seismic Performance
1. Comply with ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads" based upon seismic design criteria indicated.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Approved manufacturers listed in this section, with minimum 5 years experience in manufacture of orchestra pit fillers in use in similar environments. Obtain orchestra pit fillers through one source from a single approved manufacturer.
1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time period allowed for substitution review:
a. Product data.
b. Samples of each component of product specified.
c. Project references: Minimum of 5 installations not less than 3 years old, with owner contact information.
d. List of successful installations of similar products available for evaluation by Architect.
e. Sample warranty.
2. Submit substitution request not less than 15 days prior to bid date. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
3. Approved manufacturers must meet separate requirements of Submittals Article.

B. Source Limitations: Obtain the following products through one source from a single approved manufacturer:
1. Orchestra pit fillers.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle orchestra pit fillers in accordance with manufacturer’s recommendations. Ship to jobsite only after roughing-in, painting work, and other related finish work has been completed and installation areas are ready to accept units and recommended temperature and humidity levels will be maintained during the remainder of construction.

1.07 WARRANTY

A. Special Warranty: Manufacturer's written warranty indicating manufacturer’s intent to repair or replace components of orchestra pit fillers that fail in materials or workmanship within 5 years from date of Substantial Completion. Failures are defined to include, but are not limited to, the following:
1. Fracturing or breaking of unit components which results from normal wear and tear and normal use other than vandalism.
2. Delamination or other failures of glue bond of components.
3. Warping of components not resulting from leaks, flooding, or other uncontrolled moisture or humidity.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Orchestra pit filler design is based upon products of the manufacturers listed below. Provide basis of design product or approved comparable product. Comply with requirements of Part 1 Quality Assurance Article for approval of products not named below.

B. Wenger Corporation, Owatonna, MN;.
   1. Basis of Design Product: Strata Orchestra Pit Filler.

2.02 MATERIALS

A. Aluminum:
   1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   2. Extruded Bars, Profiles, and Tubes: ASTM B 221 (ASTM B 221M), 6063T alloy.
   3. Extruded Structural Pipe and Tube: ASTM B 429.

B. Softwood Plywood: DOC PS 1.

C. Hardboard: AHA A135.4, tempered grade.

2.03 FABRICATION, GENERAL

A. Provide orchestra pit fillers meeting requirements of System Description and Performance Requirements Articles in Part 1, with the following characteristics:
   1. Portable and storable in space indicated.
   2. Easily set up and disassembled without use of special tools or loose fasteners.

2.04 ORCHESTRA PIT FILLER

A. Framing Components:
   1. Main Support Beams: Extruded aluminum with dual fastener tracks for panel connection and adjustable beam-to-stage connection bracket fastened to stage using threaded insert and 3/8 inch (9.5 mm) diameter threaded locking device.
   2. Cross Beams: Extruded aluminum with single fastener track for panel connection, attached to main support beams with pin and socket connection requiring no tools.
   3. Column Assemblies: Extruded aluminum, with pinned connection to main support beams and threaded leveling foot allowing total adjustment of 4 inches (100 mm), plus or minus.
   4. Bracing: Aluminum or steel, attached to main support beams and cross beams, with pinned connection to columns.

B. Composite Panel Deck:
   1. Thickness: 3 9/16 inch (90 mm) overall.
   2. Panel Faces: Softwood Plywood, 11/32 inch (8.7 mm) thick, A-C Group One exterior.
   3. Core: Phenolic impregnated paper honeycomb, 2 3/4 inch (70 mm) thick.

4. Panel Edges: Extruded PVC, with glass-filled nylon corners.
5. Panel Attachments: Integral spring-loaded screw assemblies.
6. Traffic Surface: Hardboard, tempered, 1/8 inch (3.2 mm).
7. Maximum dimensions: no panel shall exceed 6’-0” in length to allow for fit into new elevator.

2.05 ACCESSORIES

A. Storage and Transport Carts: Manufacturer's standard steel tube-framed transport carts configured for panel and frame components, with heavy-duty casters and clamping safety strap, configured deck units or framing members.
   1. All storage carts shall not exceed 6’-0” in length to allow for fit into new elevator.

B. Perimeter closure panels matching horizontal surface, not less than 3/4 inch (19 mm) thick plywood, mounted to platform with clamps.

2.06 FINISHES

A. Metal Finishes:
   1. Aluminum: Mill finish.
   2. Steel: Powder-coated finish.
   3. Hardboard Opaque Primer: 100 percent acrylic latex primer, specially formulated for adhesion to impermeable surfaces. Basis of design product: Rosco, Tough Coat Primer, www.rosco.com.
   4. Top Coat: 2 coats ICI Sinclair Dulux Pro Flat Black 100% Pure Acrylic #22009990.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install orchestra pit fillers in location indicated to verify components are complete and operational.

B. Train Owner's personnel to assemble, adjust, operate, and maintain orchestra pit fillers.

C. Disassemble units following approval and store in location indicated.

D. Turn over operation and maintenance instructions to Owner.

END OF SECTION

SECTION 11 61 33 - THEATRICAL RIGGING

PART 1 - GENERAL

1.01 SUMMARY

A. This specification section includes the engineering, fabrication, furnishing, delivery and installation of new platform rigging equipment and drapery as specified in the 'Products' specifications and as indicated on the related rigging and drapery drawing documents for the Black Box.

B. Contract Documents and General Requirements apply to the work of this Section.

C. The General Contractor must submit the name of its selected Theatrical Rigging Contractor at the time of bid.

D. All bidders shall fully inform themselves of the conditions under which the work is to be performed. No additional compensation shall be allowed for any labor or item the bidder could have been fully informed of prior to the bid date.

E. While the components, quantities, and arrangements described herein and shown on the drawings indicate specific details for the realization of the platform systems, bidders may propose alternate details and components which will fulfill the functional parameters of the envisioned system. In such event, bidders shall submit a complete set of specifications and drawings, not less detailed than these and following the same general outline, together with a detailed statement indicating paragraph by paragraph wherein the equipment to be offered deviates from specifications included in this bid request. Where alternate proposals are offered, they shall be submitted with the amount to be added or deducted from the base bid which is required from all bidders.

1.02 SCOPE OF WORK

A. Work shall include the installation of all new materials and equipment necessary for the proper operation of all rigging and drapery equipment. Contractor shall furnish qualified personnel to test and adjust the equipment after installation until specified performance is attained.

B. Preparation and submission of complete engineered shop drawings for approval by the Architect and Theatre Systems Consultant.

C. Verification of conditions and dimensions at the job site.

D. The adjustment and testing of the completed installation by the contractor's personnel, subject to Architect and Theatre Systems Consultant's approval.

E. Submission of required record documents.

F. Coordination with other affected work, trades, and inspections.

G. Installation work includes, but is not limited to the following:
   1. New stage batten pipes, wire rope lift lines, and related wire rope hardware.
   2. New motorized winches and control system for stage lighting linesets.
   3. New connectors strip, ceiling junction boxes, cable management system for stage lighting linesets.
   4. New drapery curtain traveler tracks and related hardware.
   5. Supporting brackets, clips, drilled anchors, miscellaneous iron supports, and supplemental steel where required for installation of the work of this Section and not furnished under other Sections.
   6. Safety and operational instruction signs for all rigging equipment which is installed.
   7. All scaffolding, hoisting equipment, tools, etc. necessary to perform the work.

1.03 RESPONSIBILITY

A. Thoroughly review the current Architectural, Structural, Mechanical, Electrical, and other Project related drawings prior to submitting the bid proposal.

B. Organize and program the Work of the Section to harmonize with the work which will be performed by other contractors during the Project so that work will proceed as expeditiously as possible.

C. Comply with all applicable code requirements and the requirements of federal, state, and local authorities having jurisdiction over the design, fabrication, installation, and operation of the systems and associated components specified in this section.

D. Take full responsibility for the proper placing and fitting of equipment and materials furnished under this Section into the structure.

E. Design components and install equipment to fit into the structure as built.

F. Specifications only establish criteria and do not attempt to dictate specific installation details and methods which may be necessary for the successful contractor’s design; drawings related to the Work of the Section may therefore be diagrammatic.

G. Become familiar with the building construction and finishes, access and space available for equipment, and obvious interferences requiring special attention.

H. Carefully check and verify pertinent dimensions, sizes, loads and the appropriateness of structure supporting the proposed Work of this Section, both on the Drawings and in the field, before proceeding with any work.

I. Provide additional structural and support members and guards as necessary for proper installation and operation of the Work of this Section.

J. All variations from specified equipment must be approved in writing by the Architect and Theatre Systems Consultant.

K. All rigging equipment and hardware must be of new and recent manufacture.

L. All components utilized in the rigging equipment shall be specifically recommended by their manufacturer or trade organization for rigging applications. They shall be installed and used in accordance with the manufacturer's specification. All load-rated hardware must be appropriately marked and of domestic U.S. manufacture.

M. Design and engineer equipment, devices, machinery, and systems based upon the following:
1. Safety to personnel during operation, use, and maintenance.
2. Adequate strength.
3. Proper coordination of systems and elements, including impact strength, breaking strength, emergency stopping distances, acceleration and deceleration rates, and normal working stress capabilities of equipment and components.
4. Reliability, with consideration for special or unusual requirements of the unit or installation.
5. Ease of maintenance.
6. Coordination with associated and adjacent systems provided under other Sections.

N. Omissions: Where dimensions and loading capacities have been omitted from this specification, they are to be determined by the bidder in accordance with accepted industry standards and the guidelines in this section. In no way shall the Contractor be relieved of the primary responsibility to provide a safe, fully functional system.

1.04 CODES, LABELS, AND STANDARDS

A. All rigging equipment and installation methods must conform to current CBC California Building Code rules and all local codes and ordinances.

B. A manufacturer's label shall be conspicuously and permanently attached to each piece of rigging equipment. Chain, rope and wire rope are exempt from this requirement.

C. Visible and permanent system capacity information shall be displayed at a location which is easily seen by the operator.

D. Those parts of the rigging equipment which require lubrication and maintenance shall be safely and easily accessible and serviceable. The name and type of the lubricant shall be conspicuously displayed near lubrication points. Lubrication points shall be conspicuously marked.

E. Critical instructions for the rigging equipment shall be visibly mounted within view of the operator. Such instructions shall be brief and concise.

F. Conform to the applicable requirements of the current adopted editions of the following reference codes or standards:
1. Occupational Safety and Health Act.
2. Occupational Safety and Health Standards.
3. California Building Code.
4. Code for Welding in Building Construction.
5. Life Safety Code.

6. American Iron and Steel Institute (AISI).
7. American National Standards Institute (ANSI).
8. American Welding Society (AWS).
9. United States Institute for Theatre Technology (USITT).
10. Entertainment Services & Technology Association (ESTA).

1.05 QUALIFICATIONS

A. Provide the Work of this Section under a single Contractor widely experienced in the design, manufacture, and installation of theatrical rigging equipment, hardware, and draperies of the quality and complexity specified in this Section.

B. Contractor shall have been actively engaged in the theatrical rigging and drapery business for at least the past 5 consecutive years.

C. Bidders must be licensed and legally qualified as a California construction contractor at the time of bidding.

D. Maintain a competent Supervisor, acceptable to the School and the Architect, during the entire installation. Change of Supervisor during the Project is not acceptable without prior written approval from the School and the Architect.

E. Employ only experienced theatrical stage riggers on the Project.

F. Employ only certified welders, if welding is required.

1.06 SUBMITTAL DRAWINGS

A. Shop drawings shall be a single, integrated set of drawings produced by a single company on a common title block and with consistent drafting conventions through the entire set of drawings. Dates and notations for drawing revisions shall be consistent throughout all drawings and shall be located in the same location on common title blocks.

B. No references shall be made to “work by others” or “supply by others” for items that are part of the scope of work for this section.

C. Shop drawing shall be submitted on minimum 24”x36” size sheets. Equipment data sheet submittals shall be on letter-size paper and when multiple items are on a single page the item being proposed shall be identified clearly by an arrow, box, or other method.

D. Shop drawing submittals shall include the following drawings in addition to equipment data sheets for all primary rigging components:
   1. Cover sheet with complete index of drawings, identification of Project, Architect, General Contractor, Consultant, and complete Rigging Contractor contact information including name and phone number for Rigging Contractor’s project manager.
   2. Rigging plan(s) indicating placement and dimensions for all suspended rigging, operable or fixed. Minimum scale of ¼” = 1’-0”. Identify all linesets with number, function, and distance from plaster line.

3. Rigging section indicating all pipe and linesets by type and including illustrations of curtains, lighting battens, and other elements with cross section greater than a single pipe batten. Include indications of high and low trims for all variations on operable linesets. Minimum scale of ¼" = 1'-0". Identify all linesets with number, function, and distance from plaster line.
4. Rigging elevations for general purpose pipe battens, lighting battens, operable curtains including all traveler track & pipe batten hardware, and any other variations of manual or motorized rigging. Include batten attachment detail references for all lineset types. Minimum scale of ¼" = 1'-0".
5. Schedule(s) for rigging elements including batten lengths & types, arbor sizes & capacities, track types and sizes, curtain types and sizes, placement relative to a known datum reference.
6. Details of all individual rigging elements including but not limited to:
   a. Pipe battens, batten splices, all batten and arbor cable termination methods, batten marking methods.
   b. Traveler tracks and related hardware.
   c. Attachments of rigging elements to building structure.

1.07 PERMITS AND INSPECTIONS

A. Obtain and pay for required permits for and inspections of work of the Section.

B. Furnish material and work under this Section which meets or exceeds applicable legal and code requirements.

C. Perform tests required by the Architect, Owner's Representative, and authorities having jurisdiction.

1.08 SAFEGUARDS AND PROTECTION

A. Provide suitable barriers and warning signs associated with or adjacent to stage rigging and drapery installation wherever necessary for the protection or safety of workers on the Project, School's personnel, and others, both during construction and after completion of the Work of this Section. Maintain barriers and warning signs during installation of the Work of this Section.

B. Provide guards and guides at structural edges and corners and surrounding moving equipment as necessary to prevent fouling or tearing of draperies or rigging by structure, other rigging, or personnel contacts.

C. Protect materials and equipment from dirt and damage. Cover materials until just before the completion of the Project to prevent the adhesion of foreign matter or unintended paint.

D. Replace damaged or defective work or material prior to final payment request.

E. Take full responsibility for loss or injury to persons or property resulting from neglect of the above precautions.

1.09 DELIVERY AND STORAGE OF MATERIALS

A. Contractor is responsible for scheduling and timely delivery and placement of items furnished under this Section.

B. Deliver equipment and other material to the jobsite in crates, bundles, bags and drums.

C. Clearly identify on each container the item name, size, and intended use.

1.10 SPARE PARTS

A. Provide spares, spare parts and special tools for all rigging equipment if necessary for proper operation and maintenance of equipment.

1.11 RECORD DRAWINGS AND MANUALS

A. Within thirty days of final installation approval, provide to the Architect (6) copies of an 'Operating and Servicing Manual' for the hoist and rigging system. Provide (1) copy of the manual to the Theatre Systems Consultant. Each manual shall be bound in a hard cover binder and contain the following information:
   1. Final as-built shop drawings including updated equipment locations and conduit runs.
   2. Catalog data.
   3. Operating and maintenance data.
   4. Parts lists and source for parts and service.
   5. Guarantees and warrantees.
   6. Test reports.

B. Each complete manual shall include all instructions necessary for proper operation and servicing of the systems. The instructions must be written in a manner that easily describes the necessary day-to-day operating procedures.

1.12 COMPLETION

A. Before operating any equipment for demonstration or test, comply with manufacturer's preparation instructions.

B. After checkout and adjustment, the rigging systems shall be operated for approval of the School, Architect, and Theatre Systems Consultant.

C. The contractor shall provide a minimum of two (2) hours of operations and maintenance instruction for the School's staff. This is to be coordinated with the School's schedule.

D. If due to installation-caused matters the Architect or Theatre Systems Consultant is required to perform any follow-up checkout or inspection visits after the approved completion of the project, the Contractor shall compensate the Architect or Consultant at their standard hourly rates for all time expended.

1.13 INSPECTIONS

A. Inspections: Make a minimum of two inspections with operations personnel, within the guarantee period, at no expense to the School, to ensure all systems to be in satisfactory operating condition. Submit written report signed by operating personnel witnessing inspection to the School indicating inspection results with copies to the Architect and Theatre Systems Consultant.

1.14 GUARANTEE

A. Guarantee all material, rigging equipment and work for a period of two years from written acceptance of the work, against defects of any kind.

B. Parts Warranty: Obtain guarantees and/or warrantees for factory assembled equipment and include with 'Operations and Maintenance Data.'

C. Replacement: In the event of failure of any work, equipment, or device during the life of the guarantee, at no cost to School, repair or replace the defective work and remove, replace or restore any parts of the structure or building which may be damaged as the direct result of the defective work or in the course of making the replacement of defective work or materials. Any work, equipment or device replaced due to failure shall be guaranteed for a period of 2 years from date of replacement.

D. The Contractor shall provide field service maintenance, at no cost to the School, within 24 hours of notification of system malfunction. This service response shall be in effect for a period of 24 months after School's acceptance of the system.

1.15 INSURANCE

A. Provide full insurance against loss or damage during equipment shipment, storage, installation, and testing.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide only materials which are new and of first quality.

B. Use only load-rated hardware of domestic U.S. manufacture.

C. Receive from the Architect approval of design, materials, and components prior to fabrication.

D. Substitute Materials: In no case shall materials of lesser design or workmanship be deemed acceptable. Any Contractor proposing to use a substitute material or item of equipment must guarantee the suitability of the recommended substitution and provide appropriate manufacturer's literature, catalog information, cut sheets and product data sheets sufficient to permit the architect or engineer to make a meaningful and informed decision to accept the substitution. All such requests must be made at least ten days before the bid opening date. Approval of substitute equipment shall be made by addenda prior to the bid opening date.

E. Omissions: Where dimensions and loading capacities have been omitted from this specification, they are to be determined by the bidder in accordance with accepted industry standards and the guidelines in this section. In no way shall the Contractor be relieved of the primary responsibility to provide a safe, fully functional system.

F. All electrical equipment to be listed by Underwriters Laboratories (UL), the Electrical Testing Laboratories (ETL), or other recognized independent testing organization and bearing the organization's listing mark.

G. Construct and install equipment so that when the equipment is operated the sound pressure levels are minimal.

2.02 LIFT CABLES

A. All lift cables shall be 7 x 19 construction, small diameter galvanized specialty cord, ASTM 1023, sized as required for minimum safety factor of 8, and with breaking strengths as follows.
1. 1/8" diameter - 2,000 pounds
2. 3/16" diameter - 4,200 pounds
3. 1/4" diameter - 7,000 pounds
4. 5/16" diameter - 9,800 pounds
5. 3/8" diameter - 14,400 pounds

B. Damaged or deformed cable shall not be used. All wire rope rigging shall be installed so as to prevent abrasion of the wire rope against any part of the building construction or other equipment.

2.03 CABLE FITTINGS

A. Cable clips when used shall conform to wire rope manufacturer's recommendations as to size, number, and method of installation. Clips shall be drop forged Crosby or approved equal. Under no circumstances may malleable cable clips be used in suspension or lifting lines.

B. Swaged sleeve fittings shall be copper Nicopress. Swaged fittings shall be installed per the fitting manufacturer's instructions, using the appropriate tools, and checked with a 'Go - No Go' gauge.

C. Eyes shall be formed over heavy pattern, galvanized wire rope thimbles of correct sizes.

D. Turnbuckles shall be drop forged and galvanized. Turnbuckles shall be moused after adjustment to prevent loosening.

2.04 TRIM CHAINS

A. Trim chains shall be 36" long, made of 1/4" plated, grade 30 Proof Coil chain.

B. Connection between the end link and the lifting cable shall be made with a thimble and copper Nicopress sleeve. Chains shall be wrapped one and one half turns around the batten and attached back to the thimble at the end of the lift line with a 5/16" forged shackle. Adjustment is made by connecting the shackle into a link along the return side of the chain.

C. Trim chains shall have a recommended working load of at least 750 lbs.

2.05 PIPE BATTENS

A. New pipe battens shall be fabricated from full joint lengths of new 1-1/2” I.D. schedule forty black iron pipe, straightened, stripped and painted. All pipe joints shall be by means of bolted 18” internal sleeves. Threaded pipe couplings shall not be acceptable.

B. Cap pipe ends using white or yellow hemispherical plastic or neoprene rubber bumpers. Paint a 1 inch wide stripe white at the centerline of the pipe.

C. Pipe battens shall attach to lift lines by one of several methods:
1. By means of a 2-piece formed batten clamp bolted together above & below the batten and a 6”x3/8” forged turnbuckle attached to the support hole in top of batten clamp. Turnbuckles shall attach to the lift line via a eye formed in the lift line with a heavy duty thimble and copper nicropress sleeve.
2. By means of a 1/4" plated, grade 30 proof coil trim chain wrapped one and one half turns around the top batten and attached back to the thimble at the end of the lift line with a 5/16" forged shackle. Trim chains shall be 36" long and shall be terminated at the stage end of each lift line.
3. Attachment methods per project drawings.

2.06 MOTORIZED WINCH - STAGE LIGHTING ‘ELECTRIC’ LINESETS

A. The automated stage lighting electric linesets shall be user-operated integrated lineset hoist systems. Each hoist shall include a pipe batten with a 1,500 pound working load limit. Each hoist distribution connector strip shall support 20 amp 120V power circuits, DMX512 and Ethernet outputs, quantity per project drawings. The hoist system shall consist of the following components:
1. Powerhead: The Powerhead housing shall be a protective enclosure that supports the gearmotor, motor brake, load brake, limit switch assembly, limit switch adjustment system, reversing contactor, emergency contactor, wire rope drum, wire rope keeper, load cell, slack line detector and motor electronics.

2. Gearmotor and Motor Brake: The gearmotor and motor brake shall be an integral unit operating on 208 volt, 60 Hz, 3 phase power. The 2 HP gearmotor shall operate the hoist at a fixed speed averaging 30 feet per minute. The motor brake shall be spring applied and electrically released and capable of holding a minimum of 150% of the motor full load torque.
3. Load Brake: The load brake shall bring the moving load to a complete stop and hold the load in position in the event of a mechanical failure of the motor, motor brake or gearbox. The load brake shall be mounted on the same shaft as the wire rope drum. The load brake shall be mechanically released to impose only minimal force when the load is moving in the up direction. The load brake shall always be engaged when the load has stopped moving either up or down. When lowering the load the load brake shall partially disengage to allow movement but sufficient force shall be imposed to control the descending load. In the absence of rotational torque on the gearbox, the load brake shall not release.
4. Wire Rope Drum: The wire rope drum shall be capable of safely wrapping up to eight 3/16” diameter wire rope liftlines. A wire rope keeper shall assure that the liftlines wrap appropriately on the drum without crossing over or stacking.
5. Limit Switch: A mechanical limit switch shall establish firm normal and overtravel limits for movement in either direction. In addition, software shall establish resettable end of travel limits, providing each hoist with a total of three upper and three lower limits.
6. Load Sensor: The load sensor shall continuously monitor the load available for display via the hoist controller’s LCD display.
7. Slack Line Detector: The slack line detector shall prevent hoist movement downward and display a fault condition on the controller’s LCD display Slack line sensor circuitry and movement prevention shall be executed via hardware.
8. Cable Management: The load circuits and control wiring shall be fed to the hoist by a built-in cable management system that allows the flat feeder cable to fold and store along the top of the connector strip. At high trim, the entire system shall be stored in no more than 30” of vertical space from the bottom of the mounting steel to the horizontal centerline of the batten.
9. Compression Tube and Beam Clamps: The compression tube shall be a continuous channel of extruded aluminum engineered so as not to add horizontal forces on the building when used in combination with the slip fit beam clamps. The tube shall support the loft blocks mounted within the spacing limits of the system and permit their positioning anywhere along its length.
10. Loft Blocks: Each loft block shall be an assembly of steel side plates, a wire rope idler, sheave support hardware and an assembly to prevent the loft block from sliding horizontally. Each loft block shall be inserted into a slot on the bottom of the compression tube which allows loft block to be positioned up to a 4’-0” distance from a structural element of the facility. The loft block sheaves shall measure 5.25” in diameter and contain a pair of press fit sealed ball bearings. Lift lines shall travel in a groove shaped and sized for 3/16” diameter wire rope. An idler shall be incorporated into the top assembly of the loft block to guide and support lift lines as they pass the loft block.

11. Distribution Connector Strip: Power to the connector strip shall be fed via flat cable especially designed and fabricated for this system. The flat cable shall include one ground wire and one data cable plus an individually insulated hot and an individually insulated neutral conductor for each of six 120 volt circuits. The connector strip shall be built to the length specified with outlets or pigtails located as specified or as shown on the construction drawings. The flat cable shall pass through a strain relief and enter a terminal box at the designated end of the raceway. Within the raceway the wiring shall be attached to a terminal block at the factory. The wiring and all components shall meet UL requirements and appropriate National Electrical Codes (NEC).Raceway / Distribution Channel Hangers.
12. Pipe Batten: Each pipe batten shall be 1 ½" (nom.) schedule 40 grade A, seamless pipe fabricated in the largest possible lengths without splices, typically 21'-0" long. Battens longer than a single length of pipe length shall be spliced. Pipes shall be straight and painted flat black with a 1" wide white stripe at center and safety-yellow vinyl batten caps installed at each end.
13. Power and Control Distribution Box: Each hoist shall receive power and data via separate cables from a UL listed power and control distribution box. The distribution box shall include an 8 amp 3 phase motor rated breaker. Wiring and connectors shall be separated by a barrier between high and low voltage.
14. Control Panel: The control panel shall include key-operated enable switches, LCD display, hoist selection buttons, hold-to-operate buttons, a dedicated E-stop button, and an outlet for a wired remote. The UL listed controller shall operate on low voltage power supplied via CAT-5e cable that connects the control circuit to the power and control distribution box.
15. E-Stop Stations: The E-Stop station shall consist of a latching mushroom button with a rear illuminated ring surrounding the button. During normal operation the E-stop button shall be in the out position. An E-stop can be activated via this button by firmly pressing the button in. The button will latch and will immediately cause a class zero stop of all hoists in the system. To continue system operation the E-stop button must be cleared by twisting the button to release the latch. The E-Stop stations shall operate on low voltage power supplied via CAT-5e cable that connects the control circuit to the power and control distribution box.
16. Remote Control Pendant: A remote control pendant with a 30'-0" long attached cable and plug shall be provided for the system. The remote control must be plugged to the control panel and provides control for those hoists that have been preselected.

B. The following shall be supplied by the rigging contractor and installed by the electrical contractor:
   1. Hoist power and control distribution boxes, hoist control panel, and E-Stop station(s).

C. The following shall be supplied and installed by the rigging contractor.
   1. Hoist system components including but not limited to: power head, compression tube, beam clamps, loft blocks, wire rope termination hardware, and pipe battens.

D. The following shall be supplied and installed by the electrical contractor:

1. All low voltage control wiring, and conduit between the hoist control panel, E-Stop stations, and power and control distribution boxes. Terminations of all hoist low voltage control wiring shall be by the Rigging Contractor.
2. All line voltage wiring, conduit and terminations to the power and control distribution boxes.
3. All low voltage data wiring, conduit, and terminations from the stage lighting control system to the hoist flat cable termination boxes.
4. All line voltage branch circuit wiring, conduit, and terminations from the stage lighting dimmer racks to the hoist flat cable termination boxes.

2.07 MOTORIZED WINCH - GENERAL PURPOSE LINESETS

A. The motorized winches for general purpose linesets shall feature the same characteristics and operate off the same control system as those used for stage lighting electrics with the following exceptions:
   1. Winch capacity for general purpose linesets shall utilize a 900 pound working load limit.
   2. General purpose winches shall not utilize any theatrical lighting raceways and associated cable management system for power circuit and low voltage data distribution.

2.08 TRAVELER TRACKS FOR DRAPERY CURTAINS

A. Traveler tracks shall be heavy-duty, manually operated bi-parting or 1-way draw operation, straight type, with all necessary accessories for operation including live and dead end pulleys, end stops, and mounting brackets for attachment to batten pipes.

B. Track channels shall be continuous 2-5/8” by 2-3/4” (minimum size) 14-gauge steel up to 26’ long. Track shall be supplied with sufficient hanger clamps for support at a minimum 6'-0" O.C.

C. Carriers shall be spaced on 12" centers and shall be urethane-tired, sealed ball bearing assemblies. Supply heavy duty hook, swivel and 6” trim chain for curtain attachment. A rubber bumper shall be attached to each carrier to reduce noise.

D. Single end and double end pulley to utilize minimum 6” diameter nylatron sheaves with sealed ball bearings.

E. All bi-parting traveler tracks shall be provided with a stretch resistant 3/8" O.D. operating line or as required for operation with draw curtain machines.

F. Bi-parting traveler track systems shall be H&H Specialties, #418S track with #418 single carriers and #419 master carriers or approved equal. Traveler track and all components for main curtain shall be provided in black finish, H&H Specialties #418SB complete, or equal.

G. Walk-along masking legs shall be provided with two locking master carriers at each end of the curtain along with single carriers at 12" O.C. Provide a black 1/2" sash cord attached to the brake of each carrier for use in adjusting curtain position.

H. Provide a detachable floor block insert plate for each bi-parting traveler track floor block. Insert plate to be flush mounted into stage floor. Coordinate installation requirements with stage floor contractor. Floor block kit shall be H&H Specialties #432DK or equal.

2.09 DRAPERY CURTAINS

A. Submit two samples of all specially dyed, standard mill dyed, and natural fabrics to be used for drapery curtains under this section to the Architect and obtain his written approval thereof prior to dying or fabrication. Each sample of fabric shall be a minimum of 2 feet square and clearly marked to designate its intended use.

B. Permanently flameproof all draperies using the immersion process, unless fabric is inherently flameproof. Draperies shall meet the standards of NFPA 701 and CFC section 806 as well as any others which may be required by authorities having jurisdiction. All draperies shall meet the flame propagation performance criteria of CA. code of regulations, Title 19, Division 1, & CBC 410.3.6. Provide three copies of Certificates of Flameproofing treatment to the Architect for distribution to the School and Fire Department Officials.

C. Labeling of flameproof treated fabrics to include, but not limited to, the following information:
   1. Name and address of flameproofer.
   2. Date of flameproofing.
   3. Type of flameproofing compound.
   4. Manufacturer of flameproofing compound.
   5. Trade name.
   6. Age of compound at time of flameproofing for each drapery.

D. The drapery curtains shall be fabricated per the following methods:
   1. Turn top of all fabric and unless otherwise noted, attach to 3" wide, heavy synthetic webbing with a minimum of three rows of stitching. Where fullness is specified, pleat and sew to web.
   2. Hem bottom of each piece scheduled for bottom chain around 6" canvas pocket having bottom 3" above bottom of hem. Insert #8 plastic-coated or galvanized jack-chain and stitch in place to prevent bunching.
   3. Hem the sides of all curtain and drapes 4" unless specified otherwise.
   4. Install brass grommets 12" on center in webbing unless otherwise specified.
   5. Make seams straight, without puckers or wrinkles. Clip selvages 6" on center.
   6. Where specified, attach lining fabric to top web and with twill tape (at each lining seam) sewed to top of bottom hem to prevent billowing.
   7. Finished dimension of curtain drapery pieces refer to the piece in its normal hanging position, after all chains or stiffening pipes have been added, and the piece is in its "working" condition.

8. Label all curtains by marking the centerline of each leg and border at the rear of the top webbing by stitching a vertical piece of red twill tape 8” long by 3/4” wide so that the top end of the tape is level with the top of the webbing and always on the drape. Identify each border and full stage drop with labels approximately 3” by 4” attached to rear of piece at left and right bottom ends, left and right top ends (on web). Attach one label each to bottom and top (on web) ends for legs and traveler curtains, alternate left and right to correspond to offstage edge of curtains. Label shall be white cloth with indelible markings designating the finished dimensions in feet and inches.

E. The main (house, or act) curtain shall be fabricated from a synthetic inherently flame-retardant fabric, “Prestige” 25 oz. or approved equal, standard mill-dyed color selected by the Architect. The lining shall be opaque, IFR fabric. The velour pile direction shall be UP.
   1. Provide 4’ turnback of face fabric at onstage and offstage sides. Sew vertical velour strips with rolled seams, 1” wide at bottom of curtain alternating 2 feet and 3 feet long at 12” on center. Attach harness snaps, double riveted through the webbing and additional backing material if required so that the snap will not separate from the webbing under a load of 35 pounds. Bottom hem 9”.
   2. A finished sample of the front curtain, hemmed 9” on the bottom and 4” top and sides, shall be submitted to the Architect for review and written approval prior to fabrication of the curtain. The sample shall be a minimum of 4 feet wide by 2 feet high.
   3. The main curtain shall have 75% fullness.
   4. Color: 1143 Colonial Brick

F. Black masking legs shall be fabricated from a synthetic inherently flame retardant fabric, “Encore” 22 oz. or approved equal, fabricated from 64” wide bolts of fabric,. The velour pile direction shall be DOWN.
   1. Black cotton twill ties 3’-0” long shall be provided, one for each grommet plus 5% spares.
   2. The masking legs shall have 50% fullness.
   3. Each masking leg shall be provided with #8 plastic coated or galvanized jack chains and stitched into place to prevent bunching.

G. Black masking borders shall be fabricated from a synthetic inherently flame retardant fabric, “Encore” 22 oz. or approved equal, fabricated from 64” wide bolts of fabric, black. The velour pile direction shall be DOWN.
   1. Black cotton twill ties 3’-0” long shall be provided, one for each grommet plus 5% spares.
   2. The masking borders shall have 0% fullness.
   3. The bottom shall include a 6" pipe pocket that shall hold a 1/2” I.D. pipe batten 2" above the bottom of the curtain.
   4. Each border shall be provided with a 1/2” schedule 40 pipe, threaded and with couplers for the bottom pipe pocket, length as necessary to run full length width of curtain.

H. The midstage and upstage black traveler curtains shall be constructed the same as the main front curtain with the following exceptions:

1. Fabric shall be synthetic inherently flame retardant, Encore 22 oz. or approved equal, fabricated from 64” wide bolts of fabric, black.
2. Provide 2’ turnback of face fabric. The curtains shall be installed so the turnback is at onstage edge of each panel
3. Curtains shall not be lined.
4. The black traveler curtains shall have 50% fullness.
5. The velour pile direction shall be DOWN

I. The cyclorama backdrop shall be seamless unbleached natural muslin. End hems shall be 2”. The bottom hem shall be 6”. The bottom shall include a 6" pipe pocket that shall hold a 1/2” I.D. pipe batten 2" above the bottom of the curtain.
1. Provide 1/2” schedule 40 pipe, threaded and with couplers for the bottom pocket of the backdrop cyc, length as necessary to run full length width of curtain. Provide openings in bottom of pipe pocket for attachment of cyc trip lift lines. Align pocket openings with spacing of lift lines in cyc trip mechanism.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Examine all the drawings and the specifications, review all architectural and structural drawings, and include all necessary allowances or contingencies in bid proposal.

B. Resolve all conflicts with code requirements, site conditions and the work of other trades.

C. Before beginning installation, verify that approved shop drawings reflect actual field conditions and shop drawings to the Architect in writing.

D. Provide supervision and labor necessary for the complete functioning installation of the Work of this Section.

E. Coordinate the Work of this Section with the work of others.

F. Avoid interferences with piping, equipment, architectural, electrical, and structural work.

G. When interferences develop, Architect or designated representative will decide which equipment or installation must be relocated.

H. Examine construction which affects the Work of this Section to ensure that everything is in proper condition to receive the work before beginning installation of any of the Work of this Section.

I. Verify pertinent dimensions and sizes and the appropriateness of supporting structure and devices.

J. Prior to installation, notify the Architect in writing of difficulties, deficiencies, or conflicts which may prevent proper installation of the Work of this Section. Failure to do so constitutes acceptance of construction as suitable to receive the Work of this Section.

K. Request interpretations of errors or conflicts discovered in the Drawings or Specifications as necessary to accomplish the purpose of the Drawings and Specifications. Furnish and install items necessary to implement the interpretation of the Drawings and Specifications to the satisfaction of the Architect and School without additional expense.

L. Cut no beams girders, columns, or other structural members unless specifically shown on the drawing documents and approved in writing by the Architect.

M. If necessary, patch around cuts to match adjacent, uncut construction as directed by, and in a manner acceptable to the Architect.

N. Clean structural steel items of rust, scale, and other foreign matter by grinding, if necessary.

O. Contractor is responsible for repair of work or cutting of walls, floors, or other parts of the building due to contractor's neglect.

P. Repair of work or parts of the building due to contractor's neglect are this contractor's responsibility.

Q. Paint exposed metal furnished under this Section which is not factory finished or specified to have other than a painted finish.

R. Touch-up paint, field connections, welds, and abraded surfaces after erection as necessary.

S. Trim draperies before application for final payment.

T. Retrim draperies at a time acceptable to the School, at least 60 days after initial final trim.

U. Maintain the premises in a clean and orderly condition at all times. Clean up and from time to time during construction, remove all packing material and rubbish resulting from the Work of this Section from the jobsite.

V. Remove all tools, equipment, unused material, and rubbish from the jobsite upon completion of the project.

3.02 DRAPERY CURTAIN TRAVERSE TRACKS

A. Install tracks at locations shown on drawings and support as necessary for proper operation. Support operating line as necessary to prevent sag.

B. Attach carrier at dead end of track with pull rod to provide stacking and full extension of curtain.

3.03 DRAPERY CURTAINS

A. Install on battens, tracks or other locations as shown on Project drawings or specified herein.

B. Attach drapery curtains to traverse track carrier with harness snaps, unless noted otherwise.

C. Attach drapery curtains to pipe battens with cloth ties.

D. Install all soft goods plumb, straight, and without puckers.

3.04 APPROVED RIGGING CONTRACTORS

A. The Theatrical Rigging Contractor shall be one of the following accepted firms:
1. LA ProPoint
   10870 La Tuna Canyon
   Sun Valley, CA 91352
   (818) 767-6800
2. LVH Entertainment
   3685 Medford St.
   Los Angeles, CA 90063
   (805) 278-4584
3. Protech Theatrical
   3431 North Bruce Street
   North Las Vegas, NV 89030
   (702) 639-0290
4. Stagecraft Industries
   5051 North Lagoon Avenue
   Portland, OR. 97217,
   (503) 286-1600
5. Wenger / JR Clancy
   7041 Interstate Island Road
   Syracuse, NY. 1320
   (315) 451-3440

B. Other contractors seeking acceptance must meet the qualifications listed below and must submit the following materials at least 2 weeks prior to the bid opening date. Approval of contractors will be by addenda. Failure to submit any of the required information will automatically disqualify the contractor from consideration of approval.
1. Being a dealer for any of the manufacturers of equipment noted in this specification section does not constitute acceptance as an approved contractor. Only those contractors specifically mentioned as pre-approved will be accepted without substitution approval.
2. The Rigging Contractor:
   a. Shall have been a rigging manufacturer or have been an authorized representative or dealer of the manufacturer for a minimum of five years.
   b. Shall have been in business for a continuous period of at least ten years.
   c. Shall have completed at least ten installations of this type and scope within the past five years.
   d. Submit a list of ten equivalent installations completed within the last five years including:
   e. Name and address of project including date of completion and monetary value of contract.

f. Name and telephone number of Owner & Architect. Name of General Contractor or contract holder and Theatre Consultant (if applicable).
g. Listing of equipment supplied and installed including quantities of major systems or component.
h. A brief written description of the contractor's operation including facilities, financial capabilities, bonding capacity, and experience of key personnel.
i. The Architect shall be the final judge of the suitability of experience.

3.05 RIGGING HARDWARE

A. H & H Specialties

B. Automatic Devices Company

C. J.R. Clancy

D. ProTech

E. Thern Stage Equipment

3.06 DRAPERY CURTAINS

A. Rose Brand

B. KM Fabrics, Inc

C. J.B. Martin

END OF SECTION

SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes motor- operated roller shades for windows .

B. Related Sections:
1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples for Verification: For each type of roller shade.
1. Shadeband Material: Not less than 10 inches square. Mark interior face of material if applicable.
2. Installation Accessories: Full-size unit, not less than 10 inches long.

D. Product Schedule: For roller shades.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
1. Environmental Product Declarations: For products that comply with environmental product declarations.
2. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. BTX Window Automation, Inc.
2. DFB Sales.
3. Draper Inc.
4. Hunter Douglas Contract.
5. Lutron Electronics Co., Inc.
6. Nysan Solar Control Inc.; Hunter Douglas Company.
7. OEM Shades Inc.
8. Shade Techniques, LLC.
9. Silent Gliss USA, Inc.
10. SM Automatic, Inc.

B. Source Limitations: Obtain roller shades from single source from single manufacturer.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 MOTOR-OPERATED, SINGLE-ROLLER SHADES

A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
   1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
   3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
      a. Individual Switch Control Station: Maintained -contact, wall-switch-operated control station with open, close, and center off functions.
   4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
   1. Roller Drive-End Location: As indicated on Drawings.
   2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
   3. Shadeband-to-Roller Attachment: Manufacturer's standard method .

C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.

E. Shadebands:
   1. Shadeband Material: Light-filtering fabric and Light-blocking fabric.
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

F. Installation Accessories:
   1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
      a. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
   a. Height: Manufacturer's standard in height required to enclose roller and shadeband assembly when shade is fully open, but not less than as indicated on Drawings.
3. Endcap Covers: To cover exposed endcaps.
4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
   a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than height indicated on Drawings.
   b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
   a. Closure-Panel Width: As indicated on Drawings.
6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
8. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.03 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
   1. Basis-of-Design Product: As indicated on Drawings.
      a. Sustainable Design Criteria:
         1) Environmental Product Declaration.
         2) Material Health Disclosure.
   2. Source: Roller shade manufacturer.

C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
   1. Basis-of-Design Product: As indicated on Drawings.
      a. Sustainable Design Criteria:
         1) Environmental Product Declaration.
   2. Source: Roller shade manufacturer.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
   1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

C. Roller Shade Locations: As indicated on Drawings.

3.02 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.03 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 12 36 00 - COUNTERTOPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Solid surfacing countertops.

B. Related Sections:
   1. Division 01 sustainable design requirements Section(s) for supplementary sustainable design criteria.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
   2. Show locations and sizes of cutouts and holes for items installed in countertops.
   3. Apply WI Certified Compliance Program label to Shop Drawings.

C. Samples for Verification: As follows:
   1. Countertops: For each type, color, pattern, and surface finish required, 8 by 10 inches in size.
   2. Fabrication Sample: For each type and profile of countertop required, provide one sample applied to core material with specified edge material applied to one edge.

1.03 INFORMATIONAL SUBMITTALS

A. Sustainable Design Submittals:
   1. Documentation for composite wood products, indicating compliance with emissions testing or certification.
   2. Material Health Disclosures: For products that comply with requirements for material ingredient reporting.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Quality Standard: Unless otherwise indicated, comply with WI's North American Architectural Woodwork Standards (NAAWS) for grades indicated for construction, finishes, installation, and other requirements.
   1. Where the Contract Documents contain requirements that are more stringent than the referenced quality standard, comply with requirements of the Contract Documents in addition to those of the referenced quality standard.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.

B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.07 FIELD CONDITIONS

A. Environmental Limitations without Humidity Control: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.01 SUSTAINABLE DESIGN CRITERIA

A. Sustainable Design Criteria: Comply with indicated criteria for the following product categories:
   1. Composite Wood Products:
      a. Formaldehyde emissions testing or certification.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
   1. Basis-of-Design Product: As indicated on Drawings.
      a. Sustainable Design Criteria:
         1) Material Health Disclosure.
   2. Type: Provide Standard type or Veneer type made from material complying with requirements for Standard type, as indicated unless Special Purpose type is indicated.
   3. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
   4. Colors and Patterns: As indicated by manufacturer's designations.

2.03 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
   1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.
   1. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.
   2. Particleboard: ANSI A208.1, Grade M-2.

C. Plywood Subtops: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.04 SOLID SURFACING COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the WI's "North American Architectural Woodwork Standards."
   1. Grade: Premium.

B. Countertops: 3/4-inch- thick, solid surface material with front edge built up with same material.

C. Countertops: 1/4-inch- thick, solid surface material laminated to 3/4-inch- thick particleboard with exposed edges faced with 1/4-inch- thick, solid surface material.

D. Backsplashes: 3/4-inch- thick, solid surface material.

E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
   1. Fabricate with loose backsplashes for field assembly.
   2. Install integral sink bowls in countertops in the shop.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Joints: Fabricate countertops without joints.

G. Cutouts and Holes:
1. Undercounter Plumbing Fixtures: Make cutouts for fixtures using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
   a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
   b. Provide vertical edges, rounded to 3/8-inch radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch into fixture opening.
   c. Provide 3/4-inch full bullnose edges projecting 3/8 inch into fixture opening.
2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.02 SOLID SURFACING COUNTERTOP INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

F. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.

G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

H. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

3.03 ADJUSTING AND CLEANING

A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.

B. Clean countertops on exposed and semiexposed surfaces.

C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 12 36 16 - METAL COUNTERTOPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Stainless-steel countertops.

1.02 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded wall-mounted shelves.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For metal fabrications.
   1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
   2. For countertops, show locations and sizes of cutouts and holes for items installed in metal countertops.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products only after casework and supports on which they will be installed has been completed in installation areas.

B. Keep finished surfaces of products covered with polyethylene film or other protective covering during handling and installation.

1.05 FIELD CONDITIONS

A. Field Measurements: Where products are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 STAINLESS-STEEL FABRICATIONS

A. Countertops: Fabricate from 0.062-inch- thick, stainless-steel sheet. Provide smooth, clean exposed tops and edges in uniform plane, free of defects. Provide front and end overhang of 1 inch over the base cabinets.
   1. Joints: Fabricate countertops without field-made joints.
   2. Weld shop-made joints.

2.02 MATERIALS

A. Stainless-Steel Sheet: ASTM A240/A240M, Type 304.

B. Plywood Subtops: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.03 STAINLESS-STEEL FINISH

A. Grind and polish surfaces to produce uniform, directional satin finish matching No. 4 finish, with no evidence of welds and free of cross scratches. Run grain with long dimension of each piece. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces clean.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install metal countertops level, plumb, and true; shim as required, using concealed shims.

3.03 CLEANING AND PROTECTION

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces. Remove and replace damaged products or touch up and refinish damaged areas to match original factory finish, as approved by Architect.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Protection: Provide 6-mil plastic or other suitable water-resistant covering over countertop surfaces. Tape to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 12 52 19 - UPHOLSTERED SEATING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Upholstered seating cushions.

1.02 SUBMITTALS

A. Product Data.

B. Shop Drawings: Show dimensions, construction, joinery, and upholstery material pattern placement. Include material thicknesses, finishes, and attachments.

C. Verification Samples: Show full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work.
   1. Upholstery Fabric: Full-width by 36-inch- long section of material from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.

D. Maintenance Data: For custom upholstered seating to include in maintenance manuals specified in Division 01. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.

1.03 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Build mockups of one complete upholstered seating unit, including finishes and accessories:
   2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.04 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Fabric and Padding:
      a. Fabric: Class 1 according to DOC CS 191 or 16 CFR 1610, tested according to California Technical Bulletin 117-2000.
      b. Padding: Comply with California Technical Bulletin 117-2000.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2. Upholstery Assembly: Assembly shall comply with component-testing requirements of California Technical Bulletin 117-2013.
3. Full-Scale Fire Test: Comply with California Technical Bulletin 133.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fabric Upholstered Cushions:
1. Seat:
a. Padding Thickness: Minimum 3 inches at front and rear edges.
b. Top Corners: Square.
c. Upholstery Options: Welt cord trim .
d. Stitching: French.

B. Cushion Material:
1. Flexible Polyurethane Foam:
a. Seat Cushion Polymer Density: 3.0 lb/cu. ft.
b. Indentation Force Deflection: 40 lb.
c. Support Factor: 2.6.

2.02 FABRICATION

A. Double stitch seams.

B. Center upholstery pattern indicated on the inside and outside seatback and cushion, and in the same location on each seating unit. Match upholstery pattern on cushion and upholstered seat edge.

C. Apply upholstery material smooth and even, with undistorted grain lines, and free of ripples, scallops, or puckers.

D. Conceal channeled seams. Channel stitch straight and continuous, with channels parallel to each other and perpendicular to intersecting materials.

E. Fabricate removable seat cushion covers with cushion vents and concealed zippers.

F. Fabricate seat cushions and seat frame with integral, concealed, hook-type fasteners to secure cushions in place.

G. Cut welt-cord cover on bias.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas for suitable conditions where seating is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ADJUSTING AND CLEANING

A. Repair damaged and defective seating units where possible, to eliminate functional and visual defects. Where not possible to repair, replace seating units.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Fire-protection cabinets for the following:
      a. Portable fire extinguisher.
   2. Portable fire extinguishers.
   3. Mounting brackets for fire extinguishers

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
   2. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

B. Samples: For each type of exposed finish required.

C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.03 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.04 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Six years from date of Substantial Completion.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.03 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

B. Cabinet Construction: One-hour fire rated.
1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- thick cold-rolled steel sheet lined with minimum 5/8-inch- thick fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Cold-rolled steel sheet.
1. Shelf: Same metal and finish as cabinet.

D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
1. Rolled-Edge Trim: 2-1/2-inch backbend depth.

E. Cabinet Trim Material: Stainless steel sheet.

F. Door Material: Stainless steel sheet.

G. Door Style: Vertical duo panel with frame.

H. Door Glazing: Clear float glass.

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
1. Provide manufacturer's standard hinge, permitting door to open 180 degrees.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

J. Accessories:
1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

K. Materials:
1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
   a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
   b. Color: As selected by Architect from manufacturer's full range.
2. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.
   a. Finish: ASTM A480/A480M No. 4 directional satin finish, .
3. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.04 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
1. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type : UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.05 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
2. Miter corners and grind smooth.
3. Provide factory-drilled mounting holes.
4. Prepare doors and frames to receive locks.
5. Install door locks at factory.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
   1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
   2. Fabricate door frames of one-piece construction with edges flanged.
   3. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.06 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.03 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

3.04 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 12 61 00 - FIXED AUDIENCE SEATING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes fixed audience seating with the following:
   1. Standard mounting.
   2. Upholstered chairs.

1.02 SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of components, and finishes for fixed audience seating.
   2. Include electrical characteristics of electrical components, devices, and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Seating Layout: Show seating layout, aisle widths, aisle-end alignment or stepping, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of exposed color, finish, texture, and pattern indicated.
   1. Include Samples of accessories involving color and finish selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
   1. Wood and Plywood Materials and Finishes: Manufacturer's standard-size unit, not less than 3 inches square.
   2. Upholstery Fabric: Full width by 36-inch- long section of fabric from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.
   3. Row-Letter and Chair-Number Plates: Full-size units with letters and numbers marked.

E. Sample Warranty: For special warranty.

F. Operation and Maintenance Data: For fixed audience seating to include in operation and maintenance manuals.
   1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

a. Maintenance of self-rising seat mechanisms, folding armrests, and other operating components.
b. Adjustment of self-rising seat mechanisms to align seats.
c. Maintenance of electrical components, devices, and accessories.
d. Methods for maintaining upholstery fabric.
e. Precautions for cleaning materials and methods that could be detrimental to seating finishes and performance.

1.03 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fixed audience seating that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures including standards, beams, and pedestals.
b. Faulty operation of self-rising seat mechanism.
c. Faulty operation of electrical components.
d. Wear and deterioration of fabric and stitching beyond normal use.
e. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Periods: As follows, from date of Substantial Completion.
a. Structural: Lifetime.
b. Operating Mechanisms: Five years.
c. Electrical Components: Five years.
d. Plastic, Wood, and Paint Components: Five years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Hussey Seating Company.
2. Interkal LLC.
3. Irwin Telescopic Seating Company; Irwin Seating Company.
4. Royal Stewart Ltd.

2.02 MATERIALS, GENERAL

A. Source Limitations: Obtain each type of seating required, including accessories and mounting components, from single source from single manufacturer.
1. Upholstery Fabric: Obtain fabric of a single dye lot for each color and pattern of fabric required.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.03 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics of Upholstered Chairs:
   1. Fabric: Class 1 according to DOC CS 191-1953 or 16 CFR 1610, tested according to California Technical Bulletin 117.
   2. Padding: Comply with California Technical Bulletin 117.
   3. Full-Scale Fire Test: Comply with California Technical Bulletin 133.

B. Strength and Durability Performance: Chairs and components shall pass testing according to BIFMA X5.4.

C. Sustainable Design Performance Requirements:
   1. Composite wood products shall comply with the following:
      a. Testing and product requirements of the California Department of Health Services CDPH Standard Method v1.1.

2.04 FIXED AUDIENCE SEATING

A. Fixed Audience Seating: Assembly-space seating in permanent arrangement as shown on Drawings.
   1. Manufacturer: Subject to compliance with requirements, provide products by the same manufacturer as for fixed audience seating.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Hussey Seating Company; Quattro Traditional Series, or comparable product by one of the following:
      a. Hussey Seating Company.
      b. Interkal LLC.
      c. Irwin Telescopic Seating Company; Irwin Seating Company.
      d. Royal Stewart Ltd.

B. Chair Mounting Standards: Floor attached of the following material:
   1. Cast Aluminum: One-piece castings with integral mounting points and attachment anchoring points for seat pivots, backs, and armrests. Provide foot caps.

C. End Panels:
   1. Material: Hardwood-veneer plywood.
   2. Style: Tapered with square corners.

D. Fabric Upholstered Chairs:
   1. Back:
      a. Padding Thickness: 2 inches.
      b. Outer Back Surface: Hardwood-veneer plywood, with concealed fasteners.
      c. Top Corners: Soft square.
   2. Seat: Two part, top and bottom construction and as follows:
      a. Top Padding Thickness: Minimum 3 inches at front and rear edges.
      b. Seat Bottom: Molded-plastic shell.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

E. Back Height: Standard -style backs, 32-1/2 inches high.

F. Back Pitch: Fixed.
1. Back Angle: Angle for optimum viewing comfort .

G. Chair Seat Hinges: Self-lubricating, with noiseless self-rising seat mechanism passing ASTM F 851, positive internal stops cushioned with rubber or neoprene, and requiring no maintenance.
1. Self-Rising Seat Mechanism: Spring actuated, full fold.

H. Armrests: Solid hardwood with rounded edges and concealed mounting.

I. Aisle-Lighting Fixtures: Manufacturer's standard concealed-in-armrest fixtures.
1. Bulb: LED.
2. For low-voltage lighting, provide manufacturer's voltage-reduction device housed in safety enclosure equipped with fuses, terminal blocks, and safety disconnect.

J. Accessible Seating:
1. Provide chairs with folding armrest on aisle side in locations indicated, but not less than five percent of aisle seats, dispersed through the audience seating area. Identify these seats with a sign or marker.

K. Row-Letter and Chair-Number Plates: Manufacturer's standard.
1. Material: Lexan with black embossed characters.
2. Location: row letter on aisle end panel and chair number on front edge of seat.
3. Attachment: Manufacturer's standard method.

L. Accessibility-Logo Plates: Manufacturer's standard.

2.05 MATERIALS AND FINISHES

A. Exposed Plywood: HPVA HP-1, Face Grade A, hardwood-veneer core with color-matched hardwood-veneer faces.

B. Hardwood Lumber and Veneer Faces: Maple selected to be free of visible defects.
1. Stain and Finish: Natural Pear 7061.

C. Molded Plastic: High-density polyethylene or polypropylene, blow or injection molded, with surface that is mar and dent resistant.
1. Provide with UV inhibitors to retard fading.
2. Color and Texture: As selected by Architect from manufacturer's full range.

D. Fabric: Manufacturer's standard with flame-retardant treatment.
1. Color and Pattern: As selected by Architect from manufacturer's full range.

E. Upholstery Padding: Flexible, cellular, molded or slab polyurethane foam.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

F. Metal Finish: Finish exposed metal parts with manufacturer's standard minimum 1.5-mil- thick, polyester baked-on powder coating.
   1. Color: 411 Slate.

2.06 FABRICATION

A. Floor Attachments: Fabricate to conform to floor slope so that standards and pedestals are plumb and chairs are maintained at same angular relationship to vertical throughout Project.

B. Upholstery: Fabricate fabric-covered cushions with molded padding beneath fabric and with fabric covering free of welts, creases, stretch lines, and wrinkles. For each upholstered component, install pile and pattern run in a consistent direction.

C. Upholstered Chairs: Fabricate as follows:
   1. Two-Part Upholstered Back: Padded cushion glued to a curved steel, plywood, or molded-plastic inner panel and covered with easily replaceable fabric; with curved outer back shell that fully encloses upholstery edges.
   2. Two-Part, Molded-Plastic Seats: Upper part, an upholstered cushion with formed padding over a five-ply plywood panel with fabric cover conforming to shape of cushion to conceal inner seat structure and hinge mechanism. Lower part, a molded-plastic shell.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine floors, risers, and other adjacent work and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Verify that electrical connections are properly located.

C. Verify that HVAC air-distribution locations are correct.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install seating in locations indicated and fasten securely to substrates according to manufacturer's written installation instructions.
   1. Install fixed audience seating with each chair capable of complying with performance requirements without failure or other conditions that might impair the chair's usefulness.
   2. Install standards and pedestals plumb.
   3. Install seating so moving components operate smoothly and quietly.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Install seating with end standards aligned or stepped as indicated from first to last row and with backs and seats varied in width and spacing to optimize sightlines.

C. Install chairs in curved rows at a constant radius.

D. Install wiring conductors and cables concealed in components of seating and accessible for servicing.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Inspect components, assemblies, and equipment, including connections, to verify proper, complete, and sturdy installation according to manufacturer's written instructions and product specifications.
   2. Verify that seats return to correct and uniform at-rest position.

B. Fixed audience seating will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 ADJUSTING

A. Adjust chair backs so that they are at proper angles and aligned with each other in uniform rows.

B. Adjust hardware and moving parts to function smoothly so they operate easily. Lubricate bearings and sliding parts as recommended in writing by manufacturer.

C. Adjust self-rising seat mechanisms so seats in each row are aligned when in upright position.

D. Repair minor abrasions and imperfections in finishes with coating that matches factory-applied finish.

E. Replace damaged and malfunctioning components that cannot be acceptably repaired.

F. Replace upholstery fabric damaged during installation or work of other trades.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 14 42 00 - WHEELCHAIR LIFTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Vertical platform lifts.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each lift. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Manufacturer Certificates: Signed by lift manufacturer certifying that runway, ramp or pit, and dimensions as shown on Drawings and that electrical service as shown and specified are adequate for lift being provided.

E. Inspection and acceptance certificates and operating permits.

F. Operation and maintenance data.

G. Warranty: Sample of special warranty.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Regulatory Requirements: In addition to requirements of authorities having jurisdiction, comply with ASME A18.1, "Safety Standard for Platform Lifts and Stairway Chairlifts."

1.04 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lifts that fail in materials or workmanship within specified warranty period.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

1. Warranty Period: Four years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500.

C. Steel Pipe: ASTM A 53/A 53M; standard weight (Schedule 40) unless otherwise indicated or required by structural loads.

D. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel (CS), Type B, exposed, matte finish.

E. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel (CS), Type B, pickled.

F. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating.

G. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

H. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing structural members, guide rails, machines, and other lift components where installation of devices is specified in another Section.

I. Expansion Anchors: Anchor-bolt-and-sleeve assembly of material indicated below with capability to sustain a load equal to 10 times the load imposed as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

2.02 VERTICAL PLATFORM LIFTS

A. Vertical Platform Lifts: Manufacturer's standard preengineered lift systems as indicated.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Arrow Lift: Commercial Vertical Platform Lift series Model VPC EL - 144, or comparable product by one of the following:
a. Concord Elevator Inc.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

b. Flinchbaugh Company, Inc. (The).
c. Florlift of New Jersey, Inc.
d. Garaventa Accessibility.
e. Giant Lift Equipment Mfg. Co. Inc.
f. Inclinator Company of America.
g. Liftavator, Inc.
h. National Wheel-O-Vator Co., Inc. (The).
i. Savaria Corporation.
j. ThyssenKrupp Access; a ThyssenKrupp company.

B. Platform Size: As indicated on Drawings.

C. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; end door with minimum 32-inch side door with minimum 42-inch clear opening width.

D. Rated Speed: 10-20 fpm.

E. Power Supply: As indicated on Drawings.

F. Emergency Operation: Provide emergency manual operation and emergency battery power system to raise or lower units in case of malfunction or power loss.

G. Self-Supporting Units: Support vertical loads of units only at base, with lateral support only at landing levels.

H. Runway Enclosure: Manufacturer's standard enclosure assembly.

I. Platform: Galvanized-steel sheet with black rubber flooring.

J. Platform Enclosure and Door: Rectangular steel-tube frame with flush steel-sheet panels.

2.03 FINISHES

A. Steel Factory Finish: Manufacturer's standard powder-coat finish.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with ASME A18.1 and manufacturer's written instructions for installation of lifts unless otherwise indicated.

B. Minimum Headroom Clearance: Verify that installed lift will have a minimum headroom of 80 inches above any point on platform floor at any point of travel.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

C. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces.

D. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.

E. Position sills accurately and fill space under sills solidly with nonshrink, nonmetallic grout.

F. Coordinate platform doors with platform travel and positioning.

G. Adjust stops for accurate stopping at each landing, within required tolerances.

H. Adjust retractable ramps to meet maximum allowable slope and change-in-elevation requirements, and to lie fully against landing surfaces.

I. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.

3.02 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A18.1 and authorities having jurisdiction.

B. Operating Test: In addition to above testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.

3.03 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.

B. Check operation of lifts with Owner's personnel present and before date of Substantial Completion. Determine that operating systems and devices are functioning properly.

C. Check operation of lifts with Owner's personnel present not more than one month before end of warranty period. Determine that operating systems and devices are functioning properly.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 21 12 00 – FIRE SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire Protection Specialty valves.
3. Hose Connections
4. Alarm devices.
5. Pressure gauges.

B. Related Requirements:

1. Section 21 13 13 "Wet-Pipe Sprinkler Systems” for connections to fire pump/fire sprinkler supply.

2. Section 21 31 13 “Electric Drive, Vertical In-line Fire Pumps”

3. Section 28 31 11 "Digital, Addressable Fire-Alarm Systems" for connections to alarm devices.

1.3 DEFINITIONS

A. Standard-Pressure Standpipe Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, furnished specialties and accessories.

2. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
3. In addition to the above requirements, provide submittals to meet any additional requirements of the State Fire Marshal.

B. Shop Drawings: For fire suppression standpipe systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed-air piping.
3. HVAC hydronic piping.
4. HVAC equipment.
5. Items penetrating finished ceilings including the following:
   a. Lighting fixtures.
   b. Air Outlets and inlets.
6. Structural steel.

B. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Welding certificates.

D. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire suppression standpipe systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire suppression standpipes.

B. Designer Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/testing shall be Water-Based Fire Protection Systems Layout certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

C. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14 (2019 edition).

1.8 PERFORMANCE REQUIREMENTS

A. Fire suppression standpipe system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 14 2019 Edition.
2. NFPA 25 2013CA Edition.

B. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure. Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

C. Design fire suppression standpipe systems, including comprehensive engineering analysis by a Water-Based Fire Protection Systems Layout designer certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports, using performance requirements and design criteria indicated.

D. Water Supply Information

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: 2/13/2023

b. Performed by: Western States Fire Protection
c. Static Pressure at Residual Fire Hydrant R: 55 psi
d. Measured Flow at Flow Fire Hydrant F: 923 gpm
e. Residual Pressure at Residual Fire Hydrant R: 40 psi

E. The fire suppression standpipe system design shall be approved by authorities having jurisdiction.

F. Design Criteria:

1. Class III system with hose NPS 1-1/2" hose valves at each side of stage.
2. Minimum 100 gpm at 65 psig available at each outlet.

G. Seismic Performance: Fire suppression standpipe piping shall withstand the effects of earthquake motions determined according to NFPA 14 and ASCE/SEI 7.

PART 2 - GENERAL

2.1 STEEL PIPE AND FITTINGS

A. Standard-Weight Schedule 40 for 1" Black-Steel Pipe: ASTM A 53/A 53M or ASTM A 795/A 795M, Type E, Grade A steel pipe with threaded ends. Pipe ends may be factory or field formed to match joining method.

A. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 for NPS 1¼ through 10" with grooved ends.

B. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

C. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil International, Inc.
b. National Fittings, Inc.
c. Shurjoint Piping Products.

d. Smith Cooper International
e. Tyco Fire & Building Products LP.
f. Victaulic Company.
g. Viking Corporation.
h. Approved Equal.

2. Pressure Rating: 175 psig (1200 kPa)
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.2 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Globe Fire Sprinkler Corporation.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
d. Venus Fire Protection Ltd.
e. Victaulic Company.
f. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.

5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175-psig (1200-kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.3 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Notifier; a Honeywell company.
   c. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch (150-mm), 8-inch (200-mm), or 10-inch (250-mm) diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ADT Security Services, Inc.
    b. McDonnell & Miller; ITT Industries.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.
    e. Viking Corporation.
    f. Watts

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Barksdale, Inc.
    b. Detroit Switch, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.
    e. Tyco Fire & Building Products LP.
    f. United Electric Controls Co.
    g. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Kennedy Valve; a division of McWane, Inc.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AGF Manufacturing, Inc.
2. AMETEK; U.S. Gauge Division.
3. Ashcroft, Inc.
4. Brecco Corporation.
5. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 300 psig (0 to 2070 kPa).

E. Label: Include "WATER" label on dial face.

2.5 SLEEVES

A. Subject to compliance with Section 210517 “Sleeves and Sleeve Seals for Fire Suppression Piping.”

B. Sleeves for exterior walls and slabs-on-grade are also specified in Section 211100 “Facility Fire-Suppression Water-Service Piping.”

C. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

E. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

G. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

H. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

I. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set-screws.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building.

B. Install shutoff valve, alarm valve, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of fire suppression standpipe piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

G. Install standpipe piping with drains for complete system drainage.

H. Install alarm devices in piping systems.

I. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

J. Install pressure gages on riser. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they are not subject to freezing.

K. Fill fire suppression standpipe system piping with water.

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect standpipe systems according to NFPA 14, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 PIPING SCHEDULE

A. Standard-pressure, fire suppression standpipe system, NPS 1” (DN 25) and smaller, shall be any one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

B. Standard-pressure, fire suppression standpipe system, NPS 1¼" to NPS 4 (DN 32 to DN 100), shall be any one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, fire suppression standpipe system, NPS 5 (DN 125) and larger, shall be any one of the following:

1. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

END OF SECTION 21 12 00

SECTION 21 13 13 – WET PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Fire Department Connections.
5. Sprinklers.
6. Alarm devices.
7. Pressure gauges.

B. Related Requirements:

1. Section 28 31 11 "Digital, Addressable Fire-Alarm Systems" for connections to alarm devices.

2. Section 28 31 11 "Digital, Addressable Fire-Alarm Systems" for connections to alarm devices.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, furnished specialties and accessories as described in Sections 1.10 - 1.16.

2. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
3. In addition to the above requirements, provide submittals to meet any additional requirements of the State Fire Marshal.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed-air piping.
3. HVAC hydronic piping.
4. HVAC equipment.
5. Items penetrating finished ceilings including the following:
   a. Lighting fixtures.
   b. Air Outlets and inlets.
6. Structural steel.

B. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Welding certificates.

D. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

B. Designer Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/testing shall be Water-Based Fire Protection Systems Layout certified by NICET, minimum Level 2. This person’s name and certification number shall appear on the start-up and testing reports.

C. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 13 (2022 edition).

1.9 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13 2022 Edition.
2. NFPA 25 2013CA Edition.

B. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure. Retain “Delegated Design” Paragraph below if Contractor is required to assume responsibility for design.

C. Design wet-pipe sprinkler systems, including comprehensive engineering analysis by a Water-Based Fire Protection Systems Layout designer certified by NICET, minimum Level 2. This person’s name and certification number shall appear on the start-up and testing reports, using performance requirements and design criteria indicated.

D. Water Supply Information

1. Available fire-hydrant flow test records indicate the following conditions:

   a. Date: 2/13/2023
   b. Performed by: Western States Fire Protection
   c. Static Pressure at Residual Fire Hydrant R: 55 psi
   d. Measured Flow at Flow Fire Hydrant F: 923 gpm
   e. Residual Pressure at Residual Fire Hydrant R: 40 psi

2. The sprinkler system design shall be approved by authorities having jurisdiction.

   a. Margin of Safety for Available Water Flow and Pressure: 10 psi, including losses through water-service piping, valves, and backflow preventers.
   b. Sprinkler Occupancy Hazard Classifications:

      1) Offices, Counselors, Lobby, Lounge, Theater and Public Areas: Light Hazard
      2) Circulation, Band Room, Choral, Corridors, Drama, Dressing Rooms, Entry Areas, Toilets: Light Hazard
      3) Service Areas, Custodial, Fire Riser: Ordinary Hazard, Group 1.
      4) Electrical Equipment/Data Rooms: Ordinary Hazard, Group 1
      5) Mechanical Equipment Rooms: Ordinary Hazard, Group 1
      6) Kitchenette: Ordinary Hazard, Group 1
      7) General Storage Areas, Scene Shop: Ordinary Hazard, Group 2

3. Minimum Density for Automatic-Sprinkler Piping Design:

   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. design area. Reduced design area allowed per NFPA 13 Section 19.3.3.2.3.

b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. design area. Reduced design area allowed per NFPA Section 19.3.3.2.3.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. design area. Reduced design area allowed per NFPA Section 19.3.3.2.3.
d. Special Occupancy Hazard (if any): As determined by authorities having jurisdiction.

4. Maximum Protection Area per Sprinkler: According to UL listing.

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

PART 2 - GENERAL

2.1 STEEL PIPE AND FITTINGS

A. Standard-Weight Schedule 40 for 1” Black-Steel Pipe: ASTM A 53/A 53M or ASTM A 795/A 795M, Type E, Grade A steel pipe with threaded ends. Pipe ends may be factory or field formed to match joining method.

A. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 for NPS 1¼ through 10” with grooved ends.

B. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

C. Galvanized and Uncoated Steel Couplings: ASTM A 865/A 865M, threaded.

D. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

I. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil International, Inc.
b. Corcoran Piping System Co. (CPS Products Inc.).
c. National Fittings, Inc.
d. Shurjoint Piping Products.
e. Smith Cooper International
f. Tyco Fire & Building Products LP.
g. Victaulic Company.
h. Wheatland.

2. Pressure Rating: 175 psig (1200 kPa)
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.2 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Globe Fire Sprinkler Corporation.
    b. Reliable Automatic Sprinkler Co., Inc.
    c. Tyco Fire & Building Products LP.
    d. Venus Fire Protection Ltd.
    e. Victaulic Company.
    f. Viking Corporation.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Reliable Automatic Sprinkler Co., Inc.
    b. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175-psig (1200-kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.3 FIRE-DEPARTMENT CONNECTIONS

A. Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AFAC Inc.

b. Elkhart Brass Mfg. Company, Inc.
c. Fire-End & Croker Corporation.
d. Fire Protection Products, Inc.
e. GMR International Equipment Corporation.
f. Guardian Fire Equipment, Inc.
g. Tyco Fire & Building Products LP.
h. Wilson & Cousins Inc.

2. Standard: UL 405.
3. Type: Exposed, wall-mount type.
4. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Round, brass, floor type.
9. Outlet: Bottom, with pipe threads.
10. Number of Inlets: Two.
11. Sleeve: Brass
12. Sleeve Height: 18 – 48 inches (460 mm)
13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
14. Finish: Rough brass or bronze.
15. Outlet Size: NPS 6 (DN 150).

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil International, Inc.
b. National Fittings, Inc.
c. Shurjoint Piping Products.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.

2. Standard: UL 213.

3. Pressure Rating: 175-psig (1200-kPa) minimum
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Dimensions to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AGF Manufacturing Inc.
    b. Potter
    c. Reliable Automatic Sprinkler Co., Inc.
    d. Tyco Fire & Building Products LP.
    e. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig (1200-kPa) minimum
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AGF Manufacturing Inc.
    b. Elkhart Brass Mfg. Co.’ Inc.
    c. Fire-End & Croker Corp.
    d. Potter
    e. Potter Roemer LLC

2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.

8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig (1200-kPa) minimum
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Aegis Technologies, Inc.
   b. CECA, LLC.
   c. Corcoran Piping System Co.
   d. CPS Products, Inc.
   e. Merit Manufacturing; a division of Anvil International, Inc.

2. Standard: UL 1474.
3. Pressure Rating: 250-psig (1725-kPa) minimum
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ALEUM USA
b. FlexHead Industries, Inc.
c. Gateway Tubing, Inc.
d. Victaulic Company

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig (1200-kPa) minimum
5. Size: Same as connected piping, for sprinkler.

2.5 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Venus Fire Protection Ltd.
5. Victaulic Company.
6. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig (1200-kPa) maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.

E. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig (1725-kPa).

F. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767
2. Nonresidential Applications: UL 199
3. Residential Applications: UL 1626
4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

G. Sprinkler Finishes: Chrome plated, bronze, or painted.

H. Special Coatings: Wax, lead, or corrosion-resistant paint.

I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat or Chrome-plated steel, two-piece, with 1-inch (25-mm) vertical adjustment or Plastic, white finish, one piece, flat. Per Architect's requirements.
2. Sidewall Mounting: Chrome-plated steel or plastic white finish, one piece or flat.

J. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch (150-mm), 8-inch (200-mm), or 10-inch (250-mm) diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ADT Security Services, Inc.
    b. McDonnell & Miller; ITT Industries.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.
    e. Viking Corporation.
    f. Watts

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Barksdale, Inc.
    b. Detroit Switch, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.
    e. Tyco Fire & Building Products LP.
    f. United Electric Controls Co.
    g. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fire-Lite Alarms, Inc.; a Honeywell company.
    b. Kennedy Valve; a division of McWane, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    1. AGF Manufacturing, Inc.
    2. AMETEK; U.S. Gauge Division.
    3. Ashcroft, Inc.
    4. Brecco Corporation.
    5. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 300 psig (0 to 2070 kPa).

E. Label: Include "WATER" label on dial face.

2.8 SLEEVES

A. Subject to compliance with Section 210517 “Sleeves and Sleeve Seals for Fire Suppression Piping.”

B. Sleeves for exterior walls and slabs-on-grade are also specified in Section 211100 “Facility Fire-Suppression Water-Service Piping.”

C. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

E. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

G. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

H. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

I. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set-screws.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.

B. Install shutoff valve, alarm valve, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located at floor control assemblies according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between

gage and valve. Install gages to permit removal and install where they are not subject to freezing.

N. Fill sprinkler system piping with water.

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join

steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.6 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings at the center of 2’x2’ or 4’x4’ acoustical ceiling panels (ACT). Quarter-tile or center-tile location of 2’x4’ ACT is acceptable. Consult architect’s reflected ceiling plans for specific locations in crucial areas.

B. If flexible sprinkler hose fittings are utilized, install sprinkler hose fittings and hose into bracket on ceiling grid or hard-lid ceiling framing.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Standard-pressure, wet-pipe sprinkler system, NPS 1” (DN 25) and smaller, shall be any one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, wet-pipe sprinkler system, NPS 1¼" to NPS 4 (DN 32 to DN 100), shall be any one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be any one of the following:

1. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers
2. Rooms with Suspended Ceilings: Recessed pendent or concealed sprinklers as indicated within sprinkler legend.
3. Wall Mounting: Sidewall sprinklers with recessed or concealed escutcheon.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated within the sprinkler legend.
5. Special Applications: Extended-coverage where indicated.

B. Utilize subparagraphs below with finishes indicated for each type of sprinkler. All finishes are subject to approval by Owner and Architect.

1. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated wherever exposed to acids, chemicals, or other corrosive fumes.
2. Concealed Sprinklers: Rough brass, with factory-painted white cover plate or as directed by the architect or owner.
3. Recessed Sprinklers: Bright chrome or white, with bright chrome or white painted escutcheon.
4. Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

SECTION 21 30 00 ELECTRIC-DRIVE, VERTICAL IN-LINE FIRE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Vertical in-line fire pump.
2. Pressure-Maintenance (Jockey) Pump
3. Fire-pump accessories and specialties.
4. Fire-pump controllers.

1.3 PERFORMANCE REQUIREMENTS

A. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig unless higher pressure rating is indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.

1. Submit shop drawings and manufacturer's data as required to obtain the approval of all applicable local, state, and insurance authorities.

2. Submit one set of shop drawings and manufacturer's data bearing the review stamp of all applicable local, state, and insurance authorities to the architect and owner.
3. Contractor shall submit complete system packages. Partial system submittals will be rejected.
4. Prepare shop drawings at minimum scale of 1/8-inch = 1-foot for plans, and 1/4-inch = 1-foot for details. Show all piping, hangers, type of pipe, tube connections, valves, bracing, roof construction, and occupancy of each area. When welding is planned, shop drawings shall indicate the sections to be shop welded and the type of welded fittings to be used.
5. Shop Drawings shall include details of earthquake sway bracing.
6. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
7. Wiring Diagrams: For power, signal, and control wiring. Remaining paragraphs are defined in Division 01 Section “Submittal Procedures” as “Informational Submittals.”

C. Manufacturer Seismic Qualification Certification: Submit certification that fire pumps and drivers and fire-pump controllers, pressure-maintenance pumps, accessories, and specialties will withstand seismic forces defined in Division 15 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each fire pump, from manufacturer.

E. Source quality-control reports.

F. Field quality-control reports.

G. Fire pump test report.

H. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Design, installation, and testing shall comply with NFPA 20 (2019 edition), "Installation of Stationary Pumps for Fire Protection."

C. Governmental Jurisdiction: All work and materials shall conform to all State and local codes and regulations governing this installation including the current editions of the International Building Code and the International Fire Code as modified or interpreted by the Southern Nevada Consensus Amendments.

D. Code Conflict: If there is a conflict between the referenced NFPA standards, State and local codes and this specification, it shall be the Contractor’s responsibility to bring the conflict to the attention of the Owner for resolution.

E. Source Limitations: Obtain fire pumps, pressure-maintenance pumps, and controllers through one source from a single manufacturer for each type of equipment.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate with electrical contractor to provide reliable power for the electric fire pump as required per DSA IR E-3.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

A. Description: Factory-assembled and -tested fire-pump and driver unit.

B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.2 VERTICAL IN-LINE FIRE PUMPS

A. Description, General: UL 448, factory-assembled and -tested, electric-drive, centrifugal fire pumps capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.

1. Design shall be based on 100 percent of pump rated capacity per NFPA 20.

2. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.

3. Nameplate: Complete with capacities, characteristics, and other pertinent data.

B. Fabricate base and attachment to fire pumps, pressure-maintenance pumps, and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when their bases are anchored to building structure.

C. Single-Stage, Vertically Mounted, Vertical In-Line Fire Pumps: Suction-Discharge type with pump mounted on base with driver above and connected with coupling.

1. Manufacturers:

a. A-C Pump.
b. Aurora Pump.
c. Pentair Pump Group.
d. Patterson Pump Company.

2. Pump: Cast Iron Bronze fitted, Closed Coupled electric driven, self-venting, bearing free pump design. Same size suction and discharge on common centerline with flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.

a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
b. Wear Rings: Replaceable, bronze.

c. Shaft and Sleeve: Steel shaft with bronze sleeve.
   1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
   2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

D. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

E. Driver: UL-listed, NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

   a. Manufacturers:
      1) Emerson; U.S. Electrical Motors.
      2) Lincoln Electric Company (The).
      3) Marathon Electric, Inc.

F. Minimum Capacities and Characteristics (Actual rated capacity and total rated head to be determined after fire hydrant flow test is performed):

   1. Rated Capacity: 500 gpm.
   2. Total Rated Head: 50 psig.
   3. Motor Horsepower: 20.7 hp.
   4. Electrical Characteristics:
      a. Volts: 460V.
      b. Phase: Three.
      c. Hertz: 60.

G. Pump shall be soft start.

H. Seismic certification will be required for the pump.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. BERMAD Control Valves.
      b. CLA-VAL Automatic Control Valves.

c. Kunkle Valve; a part of Tyco International Ltd.
d. OCV Control Valves.
e. Watts Regulator Company; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A 53, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.
5. Manifold:

a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
c. Nipples: ASTM A 53, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
e. Escutcheon Plate: Brass or bronze; rectangular.
f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
g. Exposed Parts Finish: Brass.
h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

G. Remote status panel shall be provided in accordance with local Fire Authority. Panel and location shall be acceptable to the fire code official.

2.4 PRESSURE GAGES

A. Description: UL 393, 3-1/2 to 4-1/2 inch diameter dial with range of 0- to 300-psig; and to be “liquid-filled”. Include caption "WATER" on dial face.

1. Manufacturers:

a. AMETEK, Inc.; U.S. Gauge.
b. WIKA Instrument Corporation.

2. Suction pressure gages shall be compound pressure and vacuum gauges with a minimum 3-1/2 inch diameter dial with a pressure rating to two (2) times the maximum suction pressure.

2.5 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink and recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1. Verification of Performance: Rate fire pumps according to UL 448.

B. Fire pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

2.7 FIRE-PUMP CONTROLLERS

A. Fire-Pump Controllers, General: UL 218 and NFPA 20; listed for electric-drive, fire-pump service and service entrance; combined automatic and manual operation; factory assembled and wired; and factory tested for capacities and electrical characteristics.

1. Manufacturers

a. Firetrol, Inc.
b. Master Control Systems, Inc.
c. Metron, Inc.

2. Rate controllers for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.

3. Enclosure: UL 50, Type 2, dripproof, indoor, unless special-purpose enclosure is indicated. Include manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.

4. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.

   a. Isolating means and circuit breaker.
   b. "Power on" pilot lamp.
   c. Fire-alarm system connections for indicating motor running condition, loss-of-line power, and line-power phase reversal.
   d. Automatic and manual operation, and minimum run-time relay to prevent short cycling.
   e. Water-pressure-actuated switch with independent high and low calibrated adjustments responsive to water pressure in fire-suppression piping.
   f. Automatic and manual shutdown.
   g. System pressure recorder, electric ac driven with spring backup.

5. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.

6. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, NPS ½-inch, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch orifice.

B. Full-Service Fire-Pump Controllers:

1. Type Starting: Full-Voltage Starting.

2. Mounting: Floor type for field electrical connections.

3. Discussions with Owner relating to the possibility of provided a Solid-State Reduced Current Starting to limit the power surge from the fire pump to the building electrical system.

2.8 PRESSURE-MAINTENANCE (JOCKEY) PUMPS

A. Pressure-Maintenance Pumps, General: Factory-assembled and -tested pumps with electric-motor driver, controller, and accessories and specialties. Include cast-iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions and that connections may be threaded in sizes where flanges are not available.

1. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.

2. Nameplate: Complete with capacity, characteristics, and other pertinent data.

B. Multistage, Pressure-Maintenance Pumps: Multiple-impeller type complying with HI 1.1-1.2 and HI 1.3 requirements for multistage centrifugal pumps. Include base.

1. Manufacturers:

   a. A-C Pump.
   b. Grundfos Pumps Corp.

2. Driver: NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

C. Controllers: UL 508; factory-assembled, -wired, and -tested, across-the-line type for combined automatic and manual operation.

1. Manufacturers:

   a. Firetrol, Inc.
   b. Master Control Systems, Inc.
   c. Metron, Inc.

2. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.

   a. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.

3. Rate controller for scheduled horsepower and include the following:

a. Fusible disconnect switch.
b. Pressure switch.
c. Hand-off-auto selector switch.
d. Pilot light.
e. Running period timer.

D. Accessories and Specialties: Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:

1. Circulation relief valve.

2. Suction and discharge pressure gages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 or installation of fire pumps, relief valves, and related components.

B. Equipment Mounting: Install fire pumps on concrete bases.

1. Install per the SEOR approved anchorage plan. See fire protection drawings.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

1. Piping that is installed horizontally to have the weld seam in the 12 o'clock position.

D. Support piping and pumps separately so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section "Wet-Pipe Sprinkler Systems."

F. Install pressure gauges on fire-pump suction and discharge flange pressure-gauge tappings. Comply with requirements for pressure gauges specified in Division 21 Section "Wet-Pipe Sprinkler Systems."

G. Install piping hangers and supports, anchors, valves, gauges, and equipment supports according to NFPA 20 and NFPA 13 (2022 edition).

H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in Division 21 13 13 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
2. Test according to NFPA 20 for acceptance and performance testing.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 30 00

SECTION 22 05 00 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and all Plumbing Sections specified herein.

1.02 SCOPE OF THIS SECTION

A. Work to be furnished and installed under this Section shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction.
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record drawings
   5. Start-up and commissioning service
   6. Instruction, Training, and Operations & Maintenance Manuals
   7. Work associated with delivery, storage, and handling of products
   8. Work associated with provision of temporary facilities
   9. Preparation of posted operating instructions
   10. Meeting project safety and indemnity requirements
   11. Proper cleaning and closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of supports and anchors
   15. Design and provision of seismic restraints
   16. Design and provision of vibration isolation
   17. Through-penetration and membrane penetration firestop assemblies
   18. Hangers and supports
   19. Pipe portals
   20. Pipe stands
   21. Equipment supports
   22. Access panels and doors
   23. Roof flashings
   24. Water hammer arresters
   25. Drains
   26. Trap primers
   27. Miscellaneous fixtures
   28. Identification markers, equipment labels, pipe labels, valve tags, warning signs.
   29. Coordination of electrical requirements for equipment provided.

1.03 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to include all material and labor to install complete plumbing systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate the work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Where project involves interface with existing building and/or site systems, existing utilities and services have been indicated on the drawings to the extent possible based on available record drawings. The Contractor shall thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

E. The contractor shall design and supply all miscellaneous metals and system support components that are necessary to support all plumbing system, whether indicated or not on the drawings. Such metals and support components and related connections shall be provided as necessary to directly and concentrically impost loads on the primary structure. Refer to structural design requirements for specific attachment requirements. The plumbing system supports shall accommodate lateral movements between floors as defined in the story drift requirements.

F. The contractor shall design and supply plumbing devices and system components that are necessary to accommodate structural movement as defined by structural design criteria associated with piping transitions through building expansion joints. Design of expansion joints to allow for dimensional changes in portions of a structure separated by such joints should take both reversible and irreversible movements into account.

G. Refer to Basis of Design on drawings. Systems as specified under this section shall include, but not necessarily be limited to, the following:
   1. Connection to site utilities between two (2) and five (5) feet from the building as defined by local jurisdiction. Coordinate with the Civil Engineering Plans and/or Division 02 work.
   2. Connection of all waste, vent, and water piping to all plumbing fixtures, sinks, toilets, drinking fountains, sinks, water dispensers, drains and mechanical equipment.

1.04 SUBMITTALS

A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Supports and anchors
   2. Access panels and doors
   3. Identification markers, labels and tags
   4. Electrical equipment
   5. Pipe portals
   6. Plumbing specialties
   7. Trap primers
   8. Cleanouts
   9. Drains
   10. Roof flashing
   11. Wall hydrants and hose bibbs
   12. Backwater valves

B. Contractor shall submit a letter that all products used in the plumbing system are certified for use in the State and Municipality of the project site.

1.05 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and details of installation.
   2. Before proceeding with work check and verify all dimensions.
   3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
   4. Make adjustments that may be necessary or requested, to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
   5. Verify exact location and elevation of existing piping, ductwork, conduits and structure and coordinate to accommodate installation of new work as indicated on the drawings.
   6. If any part of Specifications or Drawings appears unclear or contradictory, apply to the Owner’s Representative for interpretation and decision as early as possible, including during bidding period.

1.06 DEFINITIONS

A. Above Grade: Not buried in the ground and not embedded in concrete slab on ground.

B. Actuating or Control Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

C. Below Grade: Buried in the ground or embedded in concrete slab on ground.

D. Building Drain: That part of the lowest piping of a drainage system that receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning 2 feet (610 mm) to 5 feet (1,524 mm) outside the building wall.

E. Building Sewer: That part of the horizontal piping of a drainage system that extends from the end of the building drain and that receives the discharge of the building drain and conveys it to a public sewer, private sewer, private sewage disposal system, or other point of disposal.

F. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

G. Connect: Complete hook-up of item with required service.

H. Drift: The horizontal deflection at the top of the story relative to the bottom of the story. Refer to structural design for drift dimensional movements.

I. Expansion Joint: A mid-structure separation designed to relieve stress on building materials caused by building movement induced by any of the following: thermal expansion and contraction; wind sway; seismic events; static load deflection; or live load deflection. Expansion joint systems are used to bridge the gap and maintain building assembly functions while accommodating expected movements. Expansion joints also include transitions from an existing building to a new building addition. Refer to structural design for expansion joint dimensional movements.

J. Exposed: Not installed underground or concealed.

K. Furnish: To supply equipment and products as specified.

L. Indicated, Shown or Noted: As indicated, shown or noted on Drawings or Specifications.

M. Install: To erect, mount and connect complete with related accessories.

N. Lead Free: Materials containing not more than 0.2 percent lead when used with respect to solder and flux and not more than a weighted average of 0.25 percent when used with respect to the wetted surfaces of pipes and pipe fittings, plumbing fittings, and fixtures, providing a specified definition and formula for determining “weighted average”.

O. Motor Controllers: Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.

P. Must: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall.

Q. NRTL: Nationally Recognized Testing Laboratory, including UL, CSA and/or ETL.

R. Piping: Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

S. Provide: To supply, install and connect as specified for a complete, safe and operationally ready system.

T. Reviewed, Satisfactory or Directed: As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner’s Representative.

U. Rough-In: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

V. Shall: An exhortation or command to complete the specified task.

W. Similar or Equal: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

X. Supply: To purchase, procure, acquire and deliver complete with related accessories.

Y. Typical or Typ: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

Z. Will: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall.

AA. Wiring: Raceway, fittings, wire, boxes and related items.

BB. Work: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.07 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 22 Plumbing sections included herein.

B. Division 01: General Requirements
   1. Including commissioning requirements.

C. Division 02: Existing Conditions
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

D. Division 03: Concrete.
   1. All concrete work required for plumbing work shall be coordinated by Division 22 with Division 03 including:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

E. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal.
   2. Sealants and caulking.
   3. Firestopping.

F. Division 09: Finishes.
   1. Division 22 installers shall perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, insulation, equipment, and materials.
   3. All exposed gas piping located exterior to the building and as required by Authority Having Jurisdiction.

G. Division 21: Fire Suppression.
   1. Fire protection contractor to provide drain piping from fire suppression risers, inspector test locations and auxiliary drain locations to approved termination outside the building or other approved locations per NFPA-13.
   2. Coordinate required indirect plumbing drain location(s), floor sinks and/or hub drains, with fire protection design. Provide minimum 3” sanitary sewer to serve riser drainage, or as shown on the drawings.

H. Division 23: HVAC.
   1. Drain inlets and sanitary sewer piping to serve all condensate and equipment drainage from mechanical equipment.
   2. Coordinate plumbing piping and drain locations with HVAC drawings.
   3. Domestic water makeup water piping, valves and backflow prevention devices to serve mechanical equipment.

I. Division 26: Electrical.
   1. Power connections to all plumbing equipment.

2. Life safety provisions.

1.08 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 22 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

E. Provide in accordance with rules and regulations of the following:
1. California Building Codes enforced by the Authority Having Jurisdiction (AHJ):
   a. 2022 Building Standards Administrative Code, Part 1, Title 24 CCR
   b. 2022 California Building Code (CBC), Part 2, Title 24 CCR (2021 International Building Code with California Amendments)
   c. 2022 California Electrical Code (CEC), Part 3, Title 24 CCR (2020 National Electrical Code with California Amendments)
   d. 2022 California Mechanical Code (CMC) Part 4, Title 24 CCR 2021 Uniform Mechanical Code with California Amendments)
   e. 2022 California Plumbing Code (CPC), Part 5, Title 24 CCR (2021 Uniform Plumbing Code with California Amendments)
   f. 2022 California Building Energy Efficiency Standards for Residential and Nonresidential Buildings (T24), Part 6, Title 24 CCR
   g. 2022 California Fire Code, Part 9, Title 24 CCR (2021 International Fire Code with California Amendments
   h. 2022 California Green Building Standards Code (CALGreen), Part 11, Title 24 CCR
2. Local jurisdiction codes and amendments
3. Local utility requirements for water, sewer and gas provisions as appropriate
4. State Fire Marshal Office
5. Health Department
6. State Administrative Codes

F. All accessible plumbing work shall comply with the Americans with Disabilities Act (ADA)and local amendments. Compliance requirements applicable to plumbing work includes, but is not limited to, the following ADA requirements:
1. Section 309: Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be five (5) pounds maximum.

2. Section 609: No plumbing fixtures or valves may impede on grab bar clearances. Grab bars are installed in a horizontal position between 33” and 36” above the finish floor to the top of the grab bar. The clear space between the wall and the grab bar shall be 1-1/2” minimum with no obstructions created by valves, fittings or controls. The space between the grab bar and projecting objects above shall be 12” minimum. The space between the grab bar and projecting objects below shall be 1-1/2” minimum.
3. Section 604.4: The seat height of a water closet above the finish floor shall be 17” minimum and 19” maximum measured to the top of the seat. Seats shall not be sprung to return to a lifted position. A water closet in a toilet room for a single occupant accessed only through a private office and not for common use or public use shall not be required to comply. In residential dwelling units the height of water closets shall be permitted to be 15” minimum and 19” maximum above the finish floor measured to the top of the seat.
4. Section 605.2: Urinal shall be a stall-type or wall-hung type with the rim 17” maximum above the finish floor or ground. Urinals shall be 13-1/2” deep minimum.
5. Section 606.3: Lavatories and sinks shall be installed with the front of the higher of the rim or counter surface 34” maximum above the finish floor.
6. Section 606.4: Hand-operated metering faucets shall remain open for 10 seconds minimum.
7. Section 606.5: Water supply and drain pipes under lavatories and sinks shall be insulated or otherwise configured to protect against contact. There shall be no sharp or abrasive surfaces under lavatories and sinks.
8. Section 602: Drinking fountain spout height shall be 36” maximum above the finish floor. The spout shall provide a flow of water 4” high minimum and shall be located 5” maximum from the front of the unit.
9. Section 608.6: A shower spray unit with a hose 59” minimum that can be used both as a fixed-position shower head and as hand-held shower. The shower spray unit shall have an on/off control with a non-positive shut-off. The shower unit shall not obstruct grad bar clearances. Shower spray units shall deliver water that does not exceed 120°F maximum.
10. Section 608.7: Thresholds in roll-in type shower compartments shall be 1/2” high maximum.

G. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association
   2. CSA - Canadian Standards Association
   3. ADC - Air Diffuser Council
   4. ANSI - American National Standards Institute
   5. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
   6. ASME - American Society of Mechanical Engineers
   7. ASTM - American Society for Testing Materials
   8. AWS - American Welding Society
   9. AWWA - American Water Works Association

10. FM - Factory Mutual
11. MSS - Manufacturer's Standardization Society
12. NEMA - National Electrical Manufacturer's Association
13. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
14. UL - Underwriter's Laboratories
15. ADA - Americans with Disabilities Act
16. ETL - Electrical Testing Laboratories
17. ASSE - American Society of Sanitary Engineers
18. PDI - Plumbing and Drainage Institute
19. IAPMO - International Association of Plumbing and Mechanical Officials
20. CISPI - Cast Iron Soil Pipe Institute

H. Provide compliance in accordance with the following referenced standard which applies to general system compliance in contrast to specific equipment standards referenced elsewhere:
   1. UL-2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces. This is applicable to spaces above suspended ceilings and below raised floors.

1.09 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Owner’s Representative for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Owner’s Representative for a decision before proceeding.

1.10 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be affixed to each piece of equipment and resistant to ambient conditions.

B. All work shall include the following:
   1. Manufactured items and equipment shall be a current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17 of the IBC, the Authority Having Jurisdiction (AHJ), and as defined in the manufacturer installation instructions for each anchorage system. Per IBC Section

1705 all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ but contracted directly with the Owner or Owner's Representative.

D. Welding Standards:
   1. Welding Qualifications:
      a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.
   2. Welding Procedures:
      a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.
      b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."

E. Pressure Piping Standards
   a. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.
   b. Comply with ASME B31.9 Building Services Piping standard for the following services:
   c. Conveying fluid between 0°F (-18°C) to 250°F (121°C).
      1) Fluid pressure less than 350 psig.
   d. Comply with ASME B31.3 Process Piping standard for the following services:
      1) Conveying fluid above 250°F (121°C).
      2) Toxic or flammable fluids.

F. Comply with minimum requirements in "Vents" chapter of local plumbing code including amendments from Authority Having Jurisdiction for termination height of vents above the roof due to localized frost and snow conditions.

1.11 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permits, licenses, fees and inspections.

D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing without impacting adjacent equipment or piping. This work shall include furnishing and installing all access doors required for mechanical access. Joints and fittings shall not be located in inaccessible locations such wall, floor and roof penetrations.

E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.

F. Coordinate plumbing equipment and materials installation with other building components.

G. Piping dimensions, as identified on drawings and in specifications, refer to the interior free dimensions. Adjust work as necessary to account for larger outside dimensions to account for material wall thickness.

H. Verify all dimensions by field measurements.

I. Arrange for chases, slots, and openings in other building components to allow for plumbing installations.

J. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

K. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.

L. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.

M. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

N. Coordinate the installation of plumbing materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

O. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised

service companies, and controlling agencies. Provide required connection for each service.

P. Coordinate with Owner's Representative in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

Q. All materials (such as insulation, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method and UL-2043.

R. Coordinate installation of floor drains and floor sinks with work of other trades. Finished floors shall slope to floor drains as shown on Architectural drawings. Floor sinks will typically be installed flush with surrounding floor. Review plans and design intent for floor sinks that may require elevated rims.

S. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

T. Pipes, pipe fittings, plumbing fittings and fixtures that come into contact with the wetted surface of a public water system or any plumbing in a facility providing water for human consumption shall be "Lead Free".

1.12 CYBERSECURITY PROTECTION

A. For all installed systems that have internet connectivity, including but not limited to controls, monitoring, metering, sensors, or other remote access capabilities, the General Contractor is responsible to request from its subcontractors a cybersecurity risk mitigation plan. All cybersecurity risk mitigation plans shall be coordinated with the owner to verify functionality and compatibility with the owner's network architecture and topology. Cybersecurity risks to be mitigated include intrusion, remote access, viruses, spy-ware, and malware. Put in-place and in-use effective protection and homogenous policies for infrastructure, servers, workstations, controllers, network connected equipment, internet connected systems/devices, WiFi devices, IOT devices and mobile devices. Where relevant and applicable, apply the requirements of ISO/IEC 27000 Series of Standards relating to "Information Technology - Security Techniques".

B. For any "highly secure environments" identified by the owner, implement relevant jurisdiction-specific standards to be performed by an accredited Information Security advisor.

C. Coordinate with Division 27 and 28 work as applicable.

1.13 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all plumbing work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting the work. The contractor's scope of work shall include:
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the plumbing plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange the work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems within the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Owner’s Representative, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner’s Representative of conflict.

1.14 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts are available locally and readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to the proposed substitution.

1.15 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Provide submittals for all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Owner’s Representative for review and approval.

C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.

D. Submittals and Shop Drawings:
1. Submit electronic copies of manufacturer's submittal sheets in one (1) coordinated package per Division. Multiple submissions will not be accepted without prior approval of the Owner’s Representative. Organize submittal sheets in sequential order aligned with matching specification section numbers.
2. Provide electronic copies of shop drawings prepared to show details of the proposed installation. Copies of contract design drawings submitted to demonstrate shop drawing compliance will not be accepted.
3. Paper submittals will only be acceptable if specifically required by Division 01.
4. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

1.16 COORDINATION DOCUMENTS/SHOP DRAWINGS

A. The Contractor shall prepare coordinated Shop Drawings using the same electronic format as the contract documents.
1. The shop drawings shall serve to record the coordination of the installation and location of all piping, fixtures, HVAC equipment, ductwork, grilles, diffusers, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances.
2. The Drawings shall include all mechanical rooms and floor plans.
3. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Owner’s Representative and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances. When conflicts are identified, modify system layout as necessary to

resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor and Owner's Representative.

4. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The coordination work shall be prepared as follows:
   1. Two dimensional AutoCAD / Revit based documents:
      a. Contractor shall prepare AutoCAD/Revit coordination drawings to an accurate scale of 1/4" = 1'-0" or larger. Drawings are to be same size as Contract Drawings and shall indicate locations, sizes and elevations above finished floor, of all systems. Lettering shall be minimum 1/8" high.
      b. Contractor shall obtain AutoCAD/Revit drawings from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the fire protection work.
      c. Plumbing drawings shall indicate locations of all fixtures and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
      d. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
      e. Drawings shall incorporate all addenda items and change orders.
      f. Distribute drawings to all other trades and provide additional coordination as needed to assure adequate space for piping, equipment and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.
   2. Three dimensional Revit / BIM based documents (if required for project):
      a. Provide three dimensional Revit model and BIM input information locating all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
      b. Contractor shall obtain Revit model and BIM input from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the fire protection work.
      c. Model shall indicate locations of all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
      d. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
      e. Model shall incorporate all addenda items and change orders.
      f. Distribute Revit model and BIM input information to all other trades and provide additional coordination as needed to assure adequate space for

equipment and piping and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.

C. Advise the Owner's Representative in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner's Representative of conflict.

D. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owner's Representative of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

1.17 REQUESTS FOR INFORMATION (RFIS)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 01).
1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
2. RFIs shall address single questions and related issues only.
3. All RFIs shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to the Owner's Design Representative.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect and Construction Manager.
6. RFI number, numbered sequentially and unique.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response for each RFI, plus additional time for Architect and General Contractor to review and forward. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:
   a. Incomplete RFIs or inaccurately prepared RFIs.
   b. RFIs submitted without indication of review and approval for submission by General Contractor or Construction Manager.
   c. RFIs addressing multiple unrelated issues.
   d. Requests for approval of submittals.
   e. Requests for approval of substitutions.
   f. Requests for approval of Contractor's means and methods.
   g. Requests for information already indicated in the Contract Documents.
   h. Requests for adjustments in the Contract Time or the Contract Sum.
   i. Requests for interpretation of Engineer's actions on submittals.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

1.18 RECORD DOCUMENTS

A. Maintain set of Coordination Documents (drawings and specifications) marked "Record Set" at the job site at all times, and use it for no other purpose but to record on it all the changes and revisions during construction.

B. Record Drawings shall indicate revisions to piping, size and location both exterior and interior; including locations control devices, and equipment requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.).

C. Record Specifications shall indicate approved substitutions; Change Orders; and actual equipment and materials provided.

D. At the completion of the construction transfer all "Record Set" notations to a clean set of drawings and specifications in a neat and orderly fashion that incorporates all site markups to clearly show all changes and revisions to the Contract Documents. Submit copies of Record Documents and CD/DVD disks labeled with all drawings and specifications and other supporting documentation.

E. Refer also to Division 01 for full scope of requirements.

1.19 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Contractor shall submit to the Owner's Representative complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section.

B. The Contractor shall be responsible for proper instruction of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 22, to be no less than two (2) hours for each type of equipment.

C. Refer to Division 01 for additional requirements.

1.20 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with manufacturer's names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping and equipment that is damaged or showing signs of rust shall be removed from site and replaced with new.

1.21 START-UP SERVICE

A. Prior to start-up, assure that systems are ready for start-up and commissioning, including checking the following: proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of controls, pumps, water heaters, and other major pieces of equipment. Certify in writing, compliance with this paragraph, stating names of personnel involved and the date work was performed.

C. Refer to other Division 01 and Division 22 sections for additional requirements.

1.22 TEMPORARY FACILITIES

A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

1.23 UNIT PRICING SUBMITTALS

A. Prior to construction submit for review all materials and equipment and pricing in accordance with Division 01 requirements.

1.24 POSTED OPERATING INSTRUCTIONS

A. Print or engrave operating instructions and frame under glass or UV resistant plastic. Post instructions as directed by Owner's Representative. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.25 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work for the duration of the project.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.26 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Owner's Representative.

1.27 WARRANTIES

A. Refer to general terms and conditions, as well as warranties and obligations defined in Division 1 of the specifications that provide basic warranty requirements for the entire project.

B. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.

C. All equipment and systems shall be provided with a minimum one-year warranty, or longer, as defined in each subsequent specification section. Warranty shall include all parts, material, labor and travel.

D. Warranty Start Date: The start date for all warranty periods shall be defined as starting from the date of Substantial Completion which shall include the Certificate of Occupancy from the Authority Having Jurisdiction.

E. Refer to individual Specification sections for additional extended warranty requirements.

F. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

G. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

H. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.28 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year, minimum, after the Certificate of Occupancy, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in this work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

C. All materials and equipment under this Division of the Specifications shall be new, of best grade and as listed in printed catalogs of the manufacturer.

D. All manufactured materials shall be delivered and stored in their original containers. Equipment shall be clearly marked or stamped with the manufacturer's name and rating.

E. For secure facilities, schools and public safety buildings exposed equipment and access shall be Vandal Proofed. One type of vandal proof screw is to be used throughout this facility. Coordinate with General Contractor for type.

F. The following products to be included as part of this work but specified under Section 220500 Basic Plumbing Materials and Methods and Section 221000 Plumbing Piping, Valves and Specialties:
   1. Piping.
   2. Valves.
   3. Hangers and supports.
   4. Escutcheon plates, flashings, and sleeves.
   5. Identification markers and signs.
   6. Anchors and alignment guides to comply with seismic requirements as indicated on structural plans.
   7. Excavation and backfill.
   8. Pressure and temperature gauges.
   9. Access Panels.

G. Plumbing Fixtures: Refer to Section 224000.

H. Plumbing Equipment: Refer to Section 223000.

I. Products made of, or containing, lead, asbestos, mercury, or other known toxic or hazardous materials are not acceptable for installation under this Section. Any such products installed as part of the work of this Section shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).

2.02 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
   1. UL: Provide products which are UL listed.
   2. FM: Provide products which are FM approved.
   3. ASCE 7-05: “American Society of Civil Engineers.”
   4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
   5. SMACNA: "Seismic Restraint Manual: Guidelines for Mechanical Systems."
   6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
   7. Provide copper plated or plastic coated supports and attachments for copper piping systems. Field applied coatings or tape is unacceptable.
   8. Manufacturer: Hilti Inc, B-Line/Tolco (Eaton), Anvil International, Erico, Empire, Kin-Line, Simpson, or Superstrut.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.

C. (Note to Editor: refer to MSS-58 images for styles allowed and not allowed:
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
   3. U-Bolts: MSS Type 24.
   4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   5. Plate: Unguided type.
   6. Plate: Guided type.
   7. Plate: Hold-down clamp type.
   8. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
   9. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
   10. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
   11. Upper Attachment Side Beam Bracket: MSS Type 34
   12. Upper Attachment Side Beam Angle Bracket: MSS Type 34, UL listed and FM Approved.
   13. Single Pipe Roller with Malleable Sockets: MSS Type 41.
   14. Adjustable Roller Hangers: MSS Type 43.
   15. Pipe Roll Stands: MSS Type 44.

16. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

D. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp type by many manufacturers.

E. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8 and or four-bolt riser clamps for heavy loads, MSS Type 42. Provide with 1” thick (minimum) neoprene pad on floor with 1/4" thick steel plate to distribute riser clamp weight to pad.
1. Pre-insulated two-bolt riser clamps up to 4” diameter. Manufacturer: Hydra-Zorb #Klo-Shure Titan Riser Clamp or equal.

F. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
1. Steel Turnbuckles: MSS Type 13.
2. Steel Clevises: MSS Type 14.
3. Swivel Turnbuckles: MSS Type 15.
4. Malleable Iron Eye Sockets: MSS Type 16.
5. Steel Weldless Eye Nuts: MSS Type 17.

G. Building Attachments: Except as otherwise indicated by the Structural Engineering design, provide factory-fabricated building attachments of one of the following types listed.
1. Concrete Inserts:
   a. MSS Type 18.
   b. Manufacturers: Hilti #KCS-MD (for metal deck) or HCI-WF (for wood forms), Simpson Strong Tie #Blue Banger Hanger, Powers Fasteners #Bang-It (for metal deck) or #Wood-Knocker (for wood forms), or equal.
2. Steel Brackets: One of the following for indicated loading:
   a. Light Duty: MSS Type 31.
   b. Medium Duty: MSS Type 32.
   c. Heavy Duty: MSS Type 33.
3. Horizontal Travelers: MSS Type 58.
4. Concrete Screw Anchors: For floor mounted attachments with maximum allowable pullout and shear force of 250 lbs. (1.1 kN) per anchor regardless of size.
   a. Manufacturers: Hilti #Kwik Hus EZ-I, Simpson Strong-Tie #Titen HD (or Rod Hanger version), Powers Fasteners #Wedge-Bolt+ (Screw Anchor), Powers Fasteners #Vertigo+ (Rod Hanger), Powers Fasteners #Snake+ (Internally Threaded Screw Anchor), or equal.

5. Torque-Controlled Expansion Anchor:
   a. Manufacturers: Hilti #Kwik Bolt TZ, Simpson Strong Tie #Strong-Bolt 2, Powers Fasteners #Power-Stud+ SD1 or Power-Stud+ SD2, or equal.
6. Screws and Bolts:
   a. Manufacturers: Bolt Depot, Fastenal, National Bolt & Nut, or equal.
7. Eye Bolts:
   a. Manufacturers: Lawson Products, Sierra Pacific, US Cargo Control, or equal.
8. Powder-Driven Concrete Anchors:
   a. Only for existing concrete structures with minimum 4000 psi concrete compressive strength.
   b. Minimum embedment of 1” (25 mm).
   c. Maximum allowable load of 50 lbs (0.2 kN) per anchor.
   d. Manufacturer: Hilti #X or D Series, Powers Fasteners #CSI Series, or equal.

H. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
2. Insulation Protection Shields: MSS Type 40, 18” minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert. Alternately Polyisocyanurate Urethane with a minimum flexural strength of 60psi, fully encased in 360 PVC (1.524 mm thick) SNAPPITZ. Provide assembly of same thickness as adjoining insulation.
4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Manufacturers: Klo-Shure Insulation Coupling or equal.

I. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards. Manufacturer: B-Line or equal.

5. Copper Pipe Brackets: Copper plated brackets. Insulate brackets attached to metal studs with felt. Manufacturer: HOLDRITE, Sioux Chief or equal.

2.03 SEISMIC RESTRAINT/VIBRATION ISOLATION REQUIREMENTS

A. Equipment, piping, and all system appurtenances (including weight of normal operating contents) shall be adequately restrained to resist seismic forces. Restraint devices shall be designed and selected to meet seismic requirements as defined in the latest code editions with State Amendments, applicable local codes, and applicable Importance Factors and Soil Factors. Refer to Section 220548 Vibration Isolation for Plumbing Equipment or Section 220549 Seismic Restraint for Plumbing Piping and Equipment, as applicable.

2.04 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-penetration and membrane penetration of fire-resistance-rated assemblies shall be caulked, sealed and/or insulated as required to maintain the fire (F) rating and temperature rise (T) rating of the penetrated assembly. Install per manufacturer's installation instructions and conform with ASTM E814 or UL 1479 and comply with Chapter 7 of the Building Code. Refer to drawings for additional requirements.

B. Through-penetrations of rated floor assemblies by floor sinks, trench drains, and similar deep plumbing fixtures, shall be protected by a firestop system with an F rating and T rating of not less than one hour but not less than the required rating of the floor penetrated. Manufacturer: 3M #System F-A-1131 or F-A-1160, Hilti #System F-A-1135 or F-A-1137, or equal systems as tested for specific installation.

C. Through-penetrations of rated floor assemblies by floor drains, tub drains or shower drains contained and located within the concealed space of a horizontal assemblies do not require compliance to a T rating.

D. Manufacturers: 3M, Hilti, Metacaulk, STI Firestop, ProSet or equal.

2.05 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20-gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Owner's Representative. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Owner's Representative.

2.06 PIPING

A. Refer to Section 221000 Plumbing Piping, Valves and Specialties

2.07 VALVES

A. Refer to Section 221000 Plumbing Piping, Valves and Specialties.

2.08 PLUMBING EQUIPMENT

A. Refer to Section 223000 Plumbing Equipment.

2.09 PLUMBING FIXTURES

A. Refer to Section 224000 Plumbing Fixtures.

2.10 CLEANOUTS

A. Acceptable Manufacturers: J.R.Smith, Zurn, Wade, Mifab, Watts, Sioux Chief and Josam.

B. Cleanout Plugs: Bronze, taper thread countersunk head.

C. Floor Cleanouts: Service weight cast-iron body and frame, flange with flashing clamp, adjustable cast-iron collar, caulk inside, Ty-seal or No-hub joints, neoprene plug gasket seal.
   1. Carpeted Areas:
      a. Medium duty, polished bronze or nickel bronze top, bronze plug, carpet clamping flange, vandal-proof screws.
      b. Manufacturers: Zurn #Z1400 Series, J.R. Smith #4020 Series, Josam #55000-1 Series or equal.
   2. Tiled Areas:
      a. Medium duty, polished nickel bronze top, bronze plug, flange with flashing clamp, vandal-proof screws.
      b. Manufacturers: Zurn #Z1400 Series, J.R. Smith #4140, #55000-1 Series or equal.

3. Unfinished Areas:
   a. Heavy duty, rough bronze top, bronze plug, flange with flashing clamp, vandal-proof screws.
   b. Manufacturers: Zurn #Z1400 Series, J.R.Smith #4100 Series, Josam #55000 Series or equal.
4. Outdoor Areas:
   a. Heavy duty, rough bronze top, bronze plug, flange with flashing clamp, vandal-proof screws.
   b. Manufacturers: Zurn #Z1474 Series, J.R. Smith #4250 Series, Josam #58680 Series or equal.

D. Cleanout Tee: Cast iron cleanout tee with countersunk bronze plug, neoprene plug gasket seal and smooth stainless steel cover.
   1. Manufacturer: Zurn #Z1446, J.R.Smith #4530 Series or equal.

2.11 ROOF FLASHING

A. Flashing: Unless indicated otherwise on the drawings flashings for pipes through the roof shall be galvanized sheet metal, 24-gauge minimum, with seams and joints lapped and soldered watertight. Coordinate with Architectural Sections for flashings and roofing.

B. Vent Pipes: Provide caulk type, vandal proof hood with Allen head vandal proof screws for all vent pipes through roof or preformed vinyl/galvanized steel assembly.

2.12 WATER HAMMER ARRESTERS

A. Provide a water hammer arrester before each quick closing valve, including but not limited to, flush valves, solenoid valves, electronic trap primers, pre-rinse faucets, dishwashers and banks of fixtures. Each water hammer arrester shall be mounted in an accessible location to facilitate installation and future replacement.

B. Piston or Bellows Type: Hard drawn copper construction or stainless steel, mirror finished internal surfaces; machine finished brass piston or stainless steel bellows, lead free, air pre-charged, 150 psi rated, threaded connection, tested and certified per PDI WH-201 and ASSE/ANSI 1010.

C. Water hammer arresters shall be sized based on the PDI WH-201 Standard method.

D. Manufacturers: Watts #LF15 Series, Precision Plumbing Products #SC Series, Sioux Chief #Hydra-Rester 650 Series, Mifab #WHB Series, JR Smith #5000 Series, or equal.

2.13 TRAP SEAL PRIMER

A. Single Fixture Trap Seal Primer Device:
   1. Device shall conform to ASSE Standard 1018 or 1044. Provide ball valve upstream of trap primer to allow for future maintenance and replacement.
   2. Pressure Operating Range: 20-80 psi.
   3. Pressure Activation: Minimum 3 psi differential and mounted with ten (10) feet of fixture source of pressure drop. Or, minimum 10 psi differential and mounted within three (3) feet of fixture source of pressure drop. Maximum pipe distance is 20 feet to floor drain.
   4. Brass body with lead free construction and removable filter screens. Chrome plated in exposed areas.
   5. Inlet and outlet connections may be threaded, unions or soldered.
   6. Manufacturer: Mifab #M-500 Series (3 psi activation), PPP #PR-500 (10 psi activation), Sioux Chief #695-01 (10 psi activation), or equal.

B. Multiple Fixture Trap Seal Primer Device:
   1. Device shall conform to ASSE Standard 1018 or 1044. Provide ball valve upstream of trap primer to allow for future maintenance and replacement.
   2. Manifold or distribution unit to serve 2 to 10 floor drains.
   3. Pressure Operating Range: 20-80 psi.
   4. Pressure Activation: Minimum 3 psi differential and mounted with ten (10) feet of fixture source of pressure drop. Or, minimum 10 psi differential and mounted within three (3) feet of fixture source of pressure drop. Maximum pipe distance is 20 feet to floor drain.
   5. Brass body with lead free construction and removable filter screens. Chrome plated in exposed areas.
   6. Inlet and outlet connections may be threaded, unions or soldered.
   7. Manufacturer: Mifab #M-500 Series (3 psi activation), PPP #P1-500 (10 psi activation), Sioux Chief #695-01 (10 psi activation), or equal.

C. Electronic Trap Seal Primer Device:
   1. Device shall conform to ASSE Standard 1018 or 1044. Provide ball valve upstream of trap primer to allow for future maintenance and replacement.
   2. Manifold or distribution unit to serve 1 to 10 floor drains.
   3. Recessed steel cabinet with stainless steel cover or galvanized steel painted to match wall.
   4. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-volt AC power. Coordinate power requirements with electrical design. Listed and labeled as defined in NFPA-70.
   5. Vacuum breaker compliant with ASSE 1001.
   6. Water hammer arrester shall be integral or externally mounted upstream.
   7. Pressure Operating Range: 20-80 psi.
   8. Brass body with lead free construction.
   9. Inlet and outlet connections may be threaded or soldered.

10. Manufacturer: Mifab #MI-100 Series, PPP #MP-500 Series, Sioux Chief #695-E Series, or equal.

2.14 DRAINS

A. Manufacturers: J.R. Smith, Zurn, Wade, Sioux Chief, Josam, Watts, or equal.

B. Provide drains of type and size as indicated in plumbing schedule on Drawings, including features, as specified herein.

C. Floor drains and shower drains installed above food preparation, and food handling areas shall be provided with integral seepage holes that drain into the drain body/pan.

2.15 ANTI-CONTAMINATION WALL HYDRANTS AND HOSE BIBBS

A. Provide fixtures of type and size as indicated in plumbing schedule on drawings, including features, as specified herein.

2.16 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 22 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils, hand printed, painted, and felt pen markers are not acceptable.
   1. Labels shall be printed to match the abbreviations or spelled out names used in the construction drawings. Custom printed labels are acceptable for specialty piping services and equipment.

B. Plastic Pipe Markers:
   1. Pre-tensioned Pipe Labels: Precoiled, semi-rigid plastic formed to partially or fully cover the circumference of pipe, or insulated pipe, and to attach to pipe without fasteners or adhesive complying with ANSI A13.1. Minimum letter size shall be 1/2” high.
   2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape. Minimum letter size shall be 1/2” high.
   3. Insulation: Furnish 1” thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2” beyond each end of plastic pipe marker.
   4. Arrows: Point each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

5. Pipe Label Color Schedule:
   a. Domestic Cold Water piping:
      1) Background Color: Green.
      2) Letter Color: White.
   b. Domestic Hot Water Supply and Domestic Hot Water Recirculation piping:
      1) Background Color: Green.
      2) Letter Color: White.
   c. Non-Potable (Recycled/Reclaim) Water piping:
      1) Background Color: Purple.
      2) Letter Color: White.
   d. Sanitary Sewer, Storm Drainage and Vent piping:
      1) Background Color: Green.
      2) Letter Color: White.
   e. Other piping services:
      1) Background Color: Comply with ANSI and ASME A13.1standards.
      2) Letter Color: Comply with ANSI and ASME A13.1standards.

C. Valve Tags:
   1. Brass Valve Tags: Provide 1-1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4” high letters and sequenced valve numbers 1/2” high, and with 5/32” hole for fastener. Fill tag engraving with black enamel.
   2. Plastic Laminate Valve Tags (indoors only): Provide 3/32” thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32” hole for fasteners.
   3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves and manufactured specifically for that purpose.

D. Access Panel Markers: Provide 1/16” thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve.

E. Plastic Equipment Signs:
   1. Provide 3” x 5” (minimum) plastic laminate sign, ANSI A.13 color coded with engraved white core lettering. Minimum letter size shall be 1/2” high.
   2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.
   4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2”x11” bond paper, tabulate each equipment identification number, and identify

Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

F. Underground-Type Plastic Line Markers: Provide 6” wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

G. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., Brimar or equal.

2.17 ELECTRICAL

A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

B. Quality Assurance:
1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:
1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors 1/2 HP or larger shall be rated for 208 or 460-volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120-volt, single phase operation.
4. Temperature Rating: Motor meets class B rise with class F insulation.

5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
    a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
    b. VFD driven motors. To be provided rated for inverter duty (NEMA Standard MG-1, Part 31) and equipped with a shaft grounding device.
    c. Bearings:
        1) Ball or roller bearings with inner and outer shaft seals.
        2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
        3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
        4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
        5) Enclosure Type:
            a) Open drip-proof (ODP) motors for indoor use in clean air environments.
            b) Totally enclosed fan cooled (TEFC) motors for outdoor use and indoor application in dirty environments.
            c) Totally enclosed air over (TEAO) motors for motors in the airstream of cooling towers and fluid coolers.
            d) Guarded drip-proof motors where exposed to contact by employees or building occupants.
            e) Weather protected Type I for outdoor use, Type II where not housed.
    d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
    e. Noise Rating: "Quiet."
    f. Efficiency:
        1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
        2) And, motors shall meet the NEMA premium efficiency standard.
    g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:
    1. Motor Starter Characteristics:
        a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
        b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
    2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type

thermal overload relays, sized according to actual operating current (field measured).

3. Magnetic Starters:
   a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
   c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
   d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
   e. Externally operated manual reset.
   f. Under-voltage release or protection for all motors over 20 hp.
4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:
1. General: 14-gauge, Type THHN, color coded, installed in conduit.
2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:
1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

2.18 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
2. Insulation to be 1-1/2” thick, 3 lb. density rigid fiberglass.
3. Curb to have a raised 3” (minimum), 45° cant.
4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).

5. Curb height to be 8” (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.
7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
8. Manufacturer: Roof Products Systems or Pate.

2.19 EQUIPMENT/PIPING RAILS

A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
2. Provide internal reinforcing supports welded as required to meet application requirements.
3. Equipment rails to have raised 3” (minimum), 45° cant.
4. Equipment rails to have 1 1/2" x 1 1/2" wood nailer (minimum) and counterflashing.
5. Equipment rail height to be 6” (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.

C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.

D. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.

PART 3 - EXECUTION

3.01 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal or otherwise irregular work, unless so indicated on Drawings or approved by Owner’s Representative.

C. Install all items specified in this section of the Specification under the full purview of local and state governing agencies.

3.02 PERFORMANCE OF WORK

A. Examine areas, physical conditions and phasing requirements under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings.

B. Work shall start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed. No foundry items to be installed until submittals have been approved.

C. Coordinate with other trades as necessary to properly interface components of the plumbing system.

D. Follow manufacturer's directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the drawings or covered in these Specifications.

E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.

3.03 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles provided on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.04 INSTALLATION

A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision, coordination or failure to make proper and timely provisions, the alterations shall be made to the satisfaction of the Owner’s Representative and at the Contractor’s cost.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defective materials.

3.05 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with all trades and testing agency representatives to coordinate work associated with placement of such work.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads,

including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where gypcrete is indicated, install reinforcing bars through opening at top of inserts.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire, stranded wire, or perforated metal to support piping, and do not support piping from other piping.

E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. All fuel gas piping shall be installed in compliance with NFPA-54 (National Fuel Gas Code) and the local Building Code. All fuel gas piping shall be attached to the building with proper supporting systems.
   1. Piping supports shall be designed and securely attached to the building to withstand special local conditions, such as wind and seismic forces, as defined in the Building Code and Chapter 5 of NFPA-54.
   2. Fuel gas piping inside the building shall not be installed in or through elevator shafts, air ducts, laundry chutes, chimneys, vents or combustion air pathways.
   3. Where piping is anchored to prevent undue strains on connected appliances and equipment this piping shall not be supported by other piping.
   4. Support fuel gas piping independently of other piping exterior to the building.
   5. Piping on roof tops shall be elevated a minimum of 6” above the roof surface and supported at maximum spacings as defined in Chapter 7 of NFPA-54 and per Code.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

I. Horizontal Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with MSS SP-58 and the SMACNA Seismic Restraint Manual using a safety factor of five). Comply with more restrictive requirements of local codes where those exceed the following minimum criteria.

1. Cast Iron:

CAST IRON PIPE SIZE	HANGER/SUPPORT SPACING (MAXIMUM)	ROD SIZE (MINIMUM)
Up to 4”	Each joint and 10 feet max	3/8”
Up to 8”	Each joint and 10 feet max	1/2”
Up to 12”	Each joint and 10 feet max	5/8”

2. Steel Pipe (Liquid Filled):

STEEL PIPE SIZE (LIQUID FILLED)	HANGER/SUPPORT SPACING (MAXIMUM)	ROD SIZE (MINIMUM)
Up to 1-1/4”	5 feet	3/8”
1-1/2” and 2”	7 feet	3/8”
2-1/2” and 3”	10 feet	1/2”
4” to 12”	10 feet	5/8"

3. Steel Pipe (Gas Filled to meet or exceed NFPA-54):

STEEL PIPE SIZE (GAS FILLED)	HANGER/SUPPORT SPACING (MAXIMUM)	ROD SIZE (MINIMUM)
1/2”	4 feet	3/8”
3/4” to 2”	6 feet	3/8”
2-1/2” to 4”	10 feet	1/2”
5” to 8”	10 feet	5/8"

4. Copper Pipe:

COPPER PIPE SIZE	HANGER/SUPPORT SPACING (MAXIMUM)	ROD SIZE (MINIMUM)
1/2"	4 feet	3/8”
3/4” to 2”	6 feet	3/8”
2-1/2” to 4”	8 feet	3/8”
5” to 8”	10 feet	1/2"

5. Caulked Bell and Spigot, Additional Support Requirements: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.

J. Vertical Support Spacing in accordance with following minimum schedules:

1. Cast Iron:

Pipe Size	Vertical Support Spacing (Maximum)
All sizes	Base and each floor, not to exceed 15 feet

2. Steel Pipe (Water and Air Filled):

Pipe Size	Vertical Support Spacing (Maximum)
All sizes	Base and every other floor, not to exceed 25 feet

3. Steel Pipe (Gas Filled):

Pipe Size	Vertical Support Spacing (Maximum)
1/2"	6 feet
3/4” to 1”	8 feet
1-1/4” and larger	Every floor level

4. Copper Pipe:

Pipe Size	Vertical Support Spacing (Maximum)
All sizes	Base and each floor, not to exceed 10 feet

K. Sloping, Air Venting, and Draining:
1. Slope all piping as specified and as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in the direction of flow as follows:

Service	Inclination	Slope
Soil and Waste	Down	1/4" per foot
Storm Water	Down	1/4" per foot
Sanitary Vent	Up (towards roof terminal)	1/4" per foot

2. Provide hose bibb valve, with threaded brass cap, at all low points in piping for maintenance draining.

L. Provisions for Movement:
1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units. Where hot water pipes are installed inside walls and ceilings do not firmly attach pipes to framing as necessary to avoid noise generation during expansion and contraction.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold water piping, install shields or inserts.
   c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

M. Installation of Anchors:
1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

4. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

N. Equipment Supports:
1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction. Coordinate size of concrete pads and placement of anchors bolts with structural design. Anchor bolts shall be placed to maintain 6”, minimum, or greater distance from concrete pad edges.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

O. Adjusting:
1. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports to align piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

P. Sanitary Roof Vents:
1. Coordinate with Architect and Roofing Installer for required height of termination and support structure as required by local environmental requirements, such as local snow, ice and wind loads. Confirm that Architect and Roof Installer have provided deflectors or splitters on the roof to protect vents where required.

3.06 WALL, FLOOR, AND ROOF PENETRATIONS

A. All pipe penetrations through rated and non-rated assemblies shall be sized to allow for compliance with structural integrity and fire ratings, as applicable. Penetrations of fire-resistance-rated assemblies shall be protected by an approved firestop system installed and tested in accordance with ASTM E119, ASTM E814, UL 263 or UL 1479. The system shall have an F rating/T rating of not less than the required rating of the floor or wall penetrated. Where sleeves are required, the sleeve size shall be installed with the inside clear diameter providing clearances as required below. Systems shall have an F rating of not less than 1 hour but not less than the required fire resistance rating of the assembly being penetrated. Systems protecting floor penetrations shall have a T rating of not less than I hour but not less than the required fire resistance rating of the floor being penetrated. Floor penetrations contained within the cavity of a wall at the location of the floor penetration do not require a T rating. No T rating shall be required for floor penetrations by piping that is not in direct contact with combustible material.

1. Uninsulated pipe penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1” (minimum) to 2” (maximum) larger than the outside diameter of each uninsulated pipe.
2. Insulated pipes penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1” (minimum) to 2” (maximum) larger than the outside diameter of each insulated pipe.
3. Uninsulated pipe penetrations through fire rated walls and floors, and through roof: penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than the outside diameter of each uninsulated pipe to provide minimum 1/4” annular space between the outside of the pipe surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
4. Insulated pipe penetrations through fire rated walls and floors, and through roof: pipe penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than the outside diameter of each insulated pipe to provide minimum 1/4” annular space between the outside of the insulation surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
5. Uninsulated pipe penetrations through foundation and basement walls: penetration sizes shall be larger than the outside diameter of each uninsulated pipe to allow adequate space for installation of mechanical link seals. Coordinate with specific manufacturer requirements.

3.07 PLUMBING FIXTURE THROUGH-PENETRATION AND MEMBRANE PROTECTION

A. Fire-resistance-rated assemblies shall be protected at membranes and/or through-penetrations where plumbing fixtures are installed in accordance with ASTM E119, ASTM E814, UL 263 or UL 1479.

B. Floor penetrations by floor drains, tub drains or shower drains contained and located within the concealed space of a horizontal assembly do not require a T rating as allowed by Chapter 7 of the Building Code.

C. Floor penetrations by floor sinks, trench drains and other fixtures that penetrate through the assembly must be enclosed within a rated enclosure with a comparable F/T rating of the assembly. Coordinate construction of fixture enclosures with Architectural design and General Contractor as required to comply with Chapter 7 of the Building Code.

D. Plumbing fixtures that penetrate into rated membranes, without penetrating through the membrane, shall be protected to maintain the fire-resistance rating of the assembly as required by Chapter 7 of the Building Code. Coordinate installation of fixtures with Architectural design and General Contractor. Manufacturer: 3M #Interam Endothermic Mat or equal.

3.08 WALL AND PIPE SIZING COORDINATION

A. Pipes routed horizontally or vertically in framed wall enclosures shall be limited to sizes that fit within the available free area without impacting the construction of the wall or

intent of architectural floor plans. Maximum piping diameters shall be adjusted as necessary to accommodate insulation, fittings and pipe crossings inside the wall enclosure. Sizing is based on the following criteria:

1. 4" Stud Wall: Maximum 2" outside diameter of pipe and/or fittings.
2. 6" Stud Wall: Maximum 4" outside diameter of pipe and/or fittings.
3. 8" Stud Wall: Maximum 6" outside diameter of pipe and/or fittings.
4. 10" Stud Wall: Maximum 8" outside diameter of pipe and/or fittings.
5. 12" Stud Wall: Maximum 10" outside diameter of pipe and/or fittings.

3.09 WATER HAMMER ARRESTERS

A. Install as per PDI WH-201 Standard and equipment manufacturer's recommendation and as shown on working drawings. Install at each plumbing fixture, bank of fixtures, equipment as required by code and where indicated on the drawings.

B. Provide upstream of quick closing valves, including but not limited to, flush valves, solenoid valves, electronic trap primers, pre-rinse faucets, dishwashers and banks of fixtures.

C. Water hammer arresters shall only be installed in the upright position above the piping and connected as close to pipe as possible to maximize effectiveness. Provide a manual ball valve (to remain in open position) at the inlet of the water hammer arrester to allow for future replacement without shutting water supply to fixtures.

D. Where water hammer arresters are installed in walls or above ceilings provide access panels as required for future maintenance and replacement. Coordinate locations with Architect or Owner's Representative prior to installation or water hammer arrester and access doors.

E. On multiple fixture branch lines up to 20 feet in length, the water hammer arrester should be installed on the branch line between the last two fixtures being served. The water hammer arrester should have a fixture unit rating equal to, or greater than, the total fixture units connected to the branch line.

F. On multiple fixture branch lines over 20 feet in length, two water hammer arresters should be used on each line with the second unit placed at the approximate midpoint of the line. The sum of the fixture unit ratings of the water hammer arresters on each branch should be equal to, or greater than, the total fixture units connected to the branch line.

G. Water hammer arresters shall be sized based on the PDI WH-201 Standard method as follows for water pressures up to 65 psi. For water pressures in excess of 65 psi provide the next larger size.

WATER HAMMER ARRESTER SIZING	
PDI SIZE RATING	FIXTURE UNITS SERVED
A	1-11
B	12-32
C	33-60
D	61-113
E	114-154
F	155-330

3.10 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust cant to match.

3.11 PIPING INSTALLATION

A. The word “piping” shall mean all pipes, fittings, nipples, valves and all accessories connected thereto.

B. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts flues, conduits and work of other trades and close to ceiling or other construction as practical, free of unnecessary traps or bends.

C. Run horizontal sanitary drainage piping at uniform pitch of not less than 1/4" per foot (2%), unless otherwise indicated on the drawings. Pitch horizontal vent piping downward from stack to fixtures.

D. Each plumbing fixture shall be properly vented as required by local plumbing code. Sanitary sewer and vent pipe sizes shall be meet or exceed minimum requirements of the local plumbing code.

E. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageway.

F. All piping shall be inspected for defects and flaws prior to installation. Remove any damaged piping from job site. Piping shall be thoroughly cleaned of dirt, debris or rust.

G. Cleanouts to be provided at each change in direction greater than 135° or 100' maximum intervals on underground piping.

H. Cleanout elevations shall be mounted flush with finished floor elevation.

I. Cleanouts to be same size as pipe except cleanout plugs larger than 4" shall not be required.

J. Cleanouts on concealed piping to be extended through and terminate flush with the finished wall or floor. Cover plates to be provided on all cleanout plugs in finished areas.

K. The bodies of cleanout ferrules to conform in thickness to that required for pipe and fittings of the same metal.

L. Mount piping on roof to manufactured polypropylene pipe supports. Manufacturers: Caddy Pyramid, Roof Top Blox or equal.

3.12 VIBRATION CONTROL ISOLATORS

A. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.

B. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

C. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

D. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

E. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

F. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.13 ELECTRICAL COORDINATION

A. Division 22 installers shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls

in accordance with the drawings and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.

C. Division 22 has responsibilities for electrically powered plumbing equipment which is specified in Division 22 Specifications or scheduled on Division 22 Drawings as follows:
   1. Motors: Furnish and install all motors necessary for mechanical equipment.
   2. Magnetic Starters: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 22 equipment, also furnish and install the power wiring between starter and motor.
   3. Variable Frequency Drives: Provide all VFD's associated with fire protection equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   4. Disconnects: Provide the disconnects which are part of factory wired Division 22 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   5. Controls: Division 22 Contractor (including the Building Automation System (BAS) Controls subcontractor) is responsible for furnishing the following equipment in its entirety. This equipment includes but is not limited to the following:
      a. Control relays necessary for controlling Division 22 equipment.
      b. Control transformers necessary for providing power to controls for Division 22 equipment.
      c. Low or non-load voltage control components.
      d. Non-life safety related valve or damper actuators.
      e. Float switches.
      f. Solenoid valves, EP and PE switches.
      g. Communications wiring and conduit between control devices and plumbing equipment.
      h. Raceway to support control cabling.

D. Division 26 Electrical Responsibilities:
   1. Motors: Provide the power wiring for the motors from servicing panel to motor controller.
   2. Magnetic Starters: Except where magnetic starters are factory installed on Division 22 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 22 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring from source panel/disconnect to the starter.

3. Variable Frequency Drives: Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 22.
4. Disconnects: Provide all disconnects necessary for Division 22 equipment which are not provided as part of factory wired Division 22 equipment. Provide power wiring to all disconnects. In addition, provide power wiring between motor and disconnect when the disconnect is not factory installed.
5. Controls: Division 26 is responsible for providing power to control panels and provide final power connection to Division 22 provided control transformers.
6. Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
7. Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and its controls.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.14 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Division 9: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, equipment, insulation, steel, etc. Exposed gas piping outside the building shall be painted.

B. All exposed work under Division 22 shall receive either a factory finish or a field prime coat finish, except:
1. Exposed copper piping.
2. Aluminum jacketed outdoor insulated piping.

3.15 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Identification is not required inside wall assemblies or under concrete slabs.

B. Piping System Identification:
1. Install pipe markers on each system indicated to receive identification and include arrows to show normal direction of flow.
2. Locate pipe markers as follows:
   a. Near each valve and control device.

b. Near each branch, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
c. Near locations where pipes pass through walls, floors, ceilings, or inaccessible enclosures.
d. At access doors, manholes, and similar access points which permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced horizontally at maximum spacing of 50' along each piping run, with minimum of one in each room. Vertically spaced at each story traversed.
g. For natural gas piping labels shall be spaced at intervals not exceeding five feet. Labels may be spaced horizontally at maximum spacing of 50' along each piping run where pipe is located in the same room or area as the appliance served, with minimum of one in each room or space. Vertically spaced at each story traversed.

3. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipe where flow is allowed in both directions.
4. Provide pipe identification on:
   a. Domestic cold water.
   b. Domestic hot water (supply and recirculation).
   c. Sanitary sewer and vent piping.
   d. Storm drainage piping.
   e. Other piping systems.

C. Valve Tag Identification: Install tags on valves and control devices in piping systems, except at check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
1. Provide valve tags for:
   a. Domestic cold water.
   b. Domestic hot water (supply and recirculation).
   c. Other piping systems.

D. Plumbing Equipment Identification: Locate engraved plastic laminate signs on or near each major item of plumbing equipment and each operational device. Additional labels are not required if systems are properly labeled by equipment manufacturers.
1. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.
2. Provide signs for the following equipment:
   a. Main control and operating valves, including safety devices.
   b. Pumps, and similar motor-driven units.
   c. Hot water system mixing valves and similar equipment.
   d. Water heaters, heat exchangers and similar equipment.
   e. Tanks and pressure vessels.
   f. Strainers, filters, treatment systems and similar equipment.

E. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install one underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. Identification is only required on piping to five feet outside the building perimeter. Underground piping identification is not required below concrete slabs.

3.16 CLEANING EQUIPMENT AND MATERIALS

A. In addition to the requirements of Section 220500, provide for the safety and good condition of all materials and equipment until final acceptance by the Owner's Representative. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care to be taken to provide protection for bearings, open connections, pipe coils, pumps, and similar equipment.

B. All piping, finished surfaces, and equipment to have all grease, adhesive labels, and foreign materials removed.

C. All piping to be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation for ten days.

D. When connections are to be made to existing systems, the Contractor is to do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

3.17 TESTING

A. Provide all tests specified herein, in other Division 22 Sections, and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Owner's Representative, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Owner's Representative to witness all field tests and conduct all field inspections. The Contractor to give the Owner's Representative ample notice of the dates and times scheduled for tests. Any deficiencies to be completely retested at no additional cost.

C. Inspection to continue during installation and testing. Perform a final inspection of the equipment prior to installation to determine conformity to the type, class, grade, size, capacity, and other characteristics specified herein or indicated. Correct or replace all rejected equipment prior to installation.

3.18 DISINFECTING - PLUMBING SYSTEMS

A. Disinfection of potable water distribution system shall be as prescribed by the local health authority or the following minimum requirement. After pressure tests have been made thoroughly flush the entire domestic water distribution system with water until all entrained dirt and mud have been removed and sterilize by chlorinating material. The chlorinating material shall be liquid chlorine. The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduced into the system or part thereof in an approved manner. Retain the treated water in the pipe for 24 hours, or, fill the system or part thereof with a water-chlorine solution containing at least 200 parts per million of chlorine and allow to stand for three (3) hours. Open and close all valves in the system being disinfected three times during the contact period. Then flush the system with clean potable water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period open and close all valves and faucets three times. From at least three divergent points in the system, take samples of water in properly sterilized containers for bacterial examination. Repeat the disinfecting until tests indicate that satisfactory bacteriological results have been obtained.

B. Taking of samples shall be witnessed by Owner's Representative. Samples are to be taken and tested by an independent analytical testing laboratory. Written reports shall be supplied to Owner's Representative for approval.

3.19 OPERATING TESTING AND CERTIFICATION - PLUMBING SYSTEMS

A. Upon completion and disinfection, and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory, functional, and operating efficiency. Such operating tests to include the following information in a report with conclusions as to the adequacy of the system.
   1. Time, date, and duration of tests.
   2. Water pressures at most remote location.
   3. Operation of all valves and hydrants.
   4. Operation of all floor drains by flooding with water.
   5. Quality of domestic water.
   6. Read all indicating instruments at half-hour intervals unless otherwise directed. Supply four copies of the test report to the Owner's Representative.

3.20 VIBRATION AND DYNAMIC BALANCING

END OF SECTION

SECTION 22 05 48 - VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SUMMARY

A. All plumbing piping and equipment as noted on the equipment schedules or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

C. All plumbing piping and equipment as noted on the equipment schedules, in the specification or as required by code shall be designed to resist seismic forces. Refer to Section 22 0549 Seismic Restraint for Piping and Equipment

D. This Section includes the following:
1. Vibration Isolation pads.
2. Vibration Isolation mounts.
3. Restrained uni-directional seismic isolation snubber mounts.
4. Spring isolators.
5. Housed seismic spring vibration mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Air-mounting system.
12. Seismic snubbers.
13. Seismic Restraining braces and cable systems for equipment, and piping.
14. Vibration isolation equipment bases.
15. Flexible piping connectors

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 22 0500: Basic Plumbing Materials and Methods

B. Section 22 0549: Seismic Restraint for Plumbing Piping and Equipment

1.04 DEFINITIONS

A. AHJ: Authority Having Jurisdiction

B. IBC: International Building Code with State Amendments.

C. CBC: California Building Code with Amendments.

D. ICC-ES: ICC-Evaluation Service.

1.05 CODES AND STANDARDS

A. Provide components conforming to the load requirements of the latest addition of the local building code and the following:
   1. International Building Code with AHJ Amendments
   2. American Society of Civil Engineers (ASCE):
      a. ASCE 7-16 (Latest Edition): Minimum Design Loads for Buildings and Other Structures
   3. The Manufacturers Standardization Society (MSS):
      a. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
      b. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
      c. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices
      d. MSS SP-127: Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
   4. Mason West Inc. Seismic Restraint Guidelines 2014 Edition
      a. For all suspended piping.

1.06 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Refer to Section 22 0549 Seismic Restraint for Plumbing Piping and Equipment for seismic specific requirements.
   2. Vibration isolators must be rated for the seismic loading associated with the system and forces calculated for this building location. Seismic forces for new installations are determined per ASCE 7. Refer to Structural Design for seismic factors and design criteria. Select and submit appropriate values for each piece of equipment and sub-system and material type for the project, and base the seismic calculations on these values.
   3. Coordinate all seismic and load requirements with the registered professional Structural Engineer.

B. Component Importance Factor:
   1. Ip=1.0: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
   2. Ip=1.5: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category; or Hospitals and Correctional Treatment Centers. Components include, but are not limited to the following:
      a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.
      b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.

1.07 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Building Structural Limits: The design of supports and restraints shall not exceed the building structure allowable point loads. Coordinate all work with the registered professional Structural Engineer.

D. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17 of the IBC, the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. Per CBC Chapter 17A all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner’s Representative.

1.08 SUBMITTALS

A. Product Data shall include the following:
   1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
   2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
   3. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   4. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
2. Provide all details of suspension and support for ceiling hung equipment.
3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint the locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

C. Manufacturer Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.

D. Coordination Drawings: Show coordination and plan locations of seismic bracing for HVAC piping, ductwork, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Structural Engineer.

F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent test agency.

G. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.09 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 22 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:
1. Standard paint applied to factory-assembled equipment before shipping.
2. Powder coating on springs and housings.
3. All hardware shall be galvanized unless otherwise noted.
4. Hot-dip galvanized of metal components for exterior use.
5. Hot-dip galvanized for metal components for interior use.

B. Glumac Device Key Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with plumbing equipment found on this project. The tag designation of preferred devices is as follows:

C.

Glumac Isolator Tag	Description
P-1	Vibration isolation waffle pad
P-2	Double deflection neoprene mount
P-3	Uni-directional restrained neoprene snubber mount
P-4	Interlocking uni-directional snubber
S-1	Open spring vibration isolator
S-2	Steel housed seismic spring vibration isolator
S-3	Bellows air spring isolator
S-4	Restrained air spring isolator
B-1	Integral equipment and motor base
B-2	Integral equipment and motor base
B-3	Concrete filled steel inertia base
H-1	Spring and rubber in shear vibration isolation hanger
G-1	All-directional pipe anchor
G-2	Vertical pipe guide
G-3	Horizontal thrust restraint
SB-1	Sway bracing

Glumac Isolator Tag	Description
F-1	Kevlar/rubber spherical type flexible piping coupling
F-2	Stainless hose flexible piping coupling
F-3	Flexible expansion joints

2.02 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
   1. Mason (OPM #0043-13), basis of selection or equal by
   2. Vibrex (OPM #0203-13)
   3. ISAT (OPM #0403-13)

B. P-1 Style: Neoprene pads shall consist of a 3/4" (19 mm) thick neoprene pad molded in square waffle modules, a minimum 1/4” (6 mm) thick steel load distribution plate and 3/4” (19 mm) hole with a neoprene anchor bolt bushing with a flat washer face. Pads may be single or multiple layers as required for leveling. Pads shall be Mason #MBSW Series or equal.

C. P-2 Style: Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall be Mason #BR Series or equal.

D. P-3 Style: All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4” (6 mm) thick. A minimum air gap of 1/8” (3 mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. No sharp edges such as bolt threads may come in contact with the neoprene bushing. Snubber end caps shall be removable to allow inspection of internal clearances. Snubber shall be Mason #Z-1225 Series.

E. P-4 Style: All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19 mm) thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3 mm) nor more that 1/4" (6 mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9 mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load

deflection curves up to 1/2" (12 mm) deflection in the x, y and z planes. Snubbers shall be Mason #Z-1011 Series.

F. S-1 Style: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Two base plate holes for attachment to support surface. Isolators shall be Mason #SLFH Series or equal.

G. S-2 Style: Restrained spring mountings shall include springs that are free standing and laterally stable and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the spring and the mounting base plate. All spring assemblies shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8” (9 m) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall be Mason #SLR Series or #SLRS Series for steel/wood connections and Mason #SLREBP Series or #SLRSEBP Series or #SSLFH Series for concrete connections.

H. S-3 Style: Multiple bellow air springs shall be manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Air springs shall be Mason #MT and leveling valves Mason #LV.

I. S-4 Style: Restrained mountings shall include multiple bellow air springs manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8” (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall have test reports or calculations certifying the maximum allowable horizontal and vertical load ratings. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Mountings shall be Mason #SLR-MT for steel connections and Mason #SLREBP for concrete connections and leveling valves Mason #LV.

2.03 VIBRATION ISOLATION STEEL EQUIPMENT BASES

A. Basis-of-Design Product: Subject to compliance with requirements provide a comparable product by one of the following:
1. Mason (OPM #0043-13), basis of selection or equal by
2. Vibrex (OPM #0203-13)
3. ISAT (OPM #0403-13)

B. B-1 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded structural steel angle or channel members. Base shall be Mason #MSL Series.

C. B-2 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded wide flange structural steel main members with cross bracing located at or near each restraint location. Where height saving brackets are required, they shall be employed in all mounting locations to maintain a 1" (25 mm) clearance below the base. Base shall be Mason #WFSL Series.

D. B-3 Style: Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows and shall be 6”deep for pumps thru 75 HP and 10” deep for pumps 100 HP thru 250HP. Forms shall include minimum concrete reinforcing consisting of #4 bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Base shall be Mason #BMK Series or #KSL Series.

2.04 SPRING HANGERS

A. H-1 Style: Spring hangers shall consist of rigid steel frames containing minimum 1-1/4” (32 mm) thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. A seismic rebound washer made of steel and surrounding neoprene shall be provided. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Hangers shall be Mason #RW30N Series.

2.05 PIPE GUIDES AND SUPPORTS

A. G-1 Style: All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 1/2" (12 mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be Mason #ADA Series.

B. G-2 Style: Vertical sliding pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (20 mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of 1-5/8" (41 mm) upwards or downwards motion, or to meet location requirements. Pipe guides shall be Mason #VSG Series.

C. G-3 Style: Horizontal thrust restraints shall consist of a spring element seated in a steel washer reinforced neoprene cup at the bottom, in series with a molded neoprene element. Steel springs shall be free standing and laterally stable. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6 mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and piping or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be Mason #WBI Series or #WBD Series.

2.06 SWAY BRACING

A. SB-1 Style: Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles or struts. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of two (2). Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Do not mix cable and steel braces to brace the same system or equipment. Brace assemblies and rod clamps shall have an Anchorage Preapproval "OPM" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable brace assemblies shall be Mason #SCB Series or #SCBH Series, steel brace assemblies shall be Mason #SSB Series, #SSBS Series or #SHB Series, and rod clamps shall be Mason #SRC Series or #UCC Series.

2.07 FLEXIBLE PIPING CONNECTORS

A. F-1 Style: Flexible spherical expansion joints for pump connections. Shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Manufacturer shall provide pre-stretching charts for expansion joints when used in conjunction with isolated equipment. Control rods need only be used in

unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be Mason #SAFEFLEX SFDEJ Series, #SAFEFLEX SFEJ Series, #SAFEFLEX SFDCR Series or #SAFEFLEX SFU Series and Control Rods Mason #CR.

B. F-2 Style: Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75 mm) and larger shall be flanged. Smaller sizes shall have male threaded nipples or copper sweat ends. Hoses must have sufficient length, minimum 12” (300 mm) long, to accept 1/2” (12 mm) intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be Mason #FFL Flanged Series, #CPSB Copper Sweat Series or #CSAMN Threaded Series

C. F-3 Style: Flexible Vee or U-bend braided hose across building or expansion joints. Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose Vee assemblies rated for ±4” (100mm) seismic motion in all planes. Should the application include ±6” (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial. Vees shall have a minimum burst pressure of four times their rated pressure. Vees in steel lines shall have stainless hose and braid. Copper lines, bronze hose and braid. Guiding and anchoring shall be as recommended by the manufacturer. 60° Vees shall be Mason #VFL flanged braided steel Series, #VMN Threaded Braided Stainless Steel Series or #VCPSB Copper Sweat Series.

2.08 BRACING DEVICES FOR EQUIPMENT AND PIPING.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Kinetics Noise Control
6. Loos & Co.
7. Mason Industries
8. Tolco Incorporated
9. Unistrut
10. ISAT, Inc

11. Vibro-Acoustics, Inc.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least two (2) times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4” (6 mm) thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.

F. Bushings for Floor-Mounted Equipment Anchorage: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.01 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

A. The following Tables provide schedules for vibration devices required for isolation of plumbing equipment provided on the project. Refer to Part 2 above for device specifications.
1. Pumps – Equipment Isolation

TABLE 1: EQUIPMENT ISOLATION SCHEDULE – PUMPS

EQUIPMENT	LOCATION								
	CRITICAL ROOF OR FLOOR (35' - 50' SPAN)			UPPER STORY (20' - 35' SPAN)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
PUMPS									
Base and Close Coupled Floor Mounted									
Up to 5 HP	S–2/S-1	0.75	B-2	S–2/S-1	0.75	B-1	S–2/S-1	0.4	B-1
7-1/2 HP & Over	S–2/S-1	1.5	B-2	S–2/S-1	1.5	B-2	S–2/S-1	0.75	B-2
Vertical Split Case Floor Mounted									
Up to 5 HP	P-1	0.15	NA	P-1	0.15	NA	P-1	0.15	NA
7-1/2 HP & Over	S–2/S-1	1.5	B-2	S–2/S-1	1.5	B-2	P-1	0.15	NA
Suspended Inline	H-1	1.75	NA	H-1	1.75	NA	H-1	1.0	NA

Notes:

(1) Alternate: Factory installed by equipment manufacturer.

(2) Provide full perimeter steel welded frame below equipment

(3) Provide support per manufacturer's recommendation

(4) Provide F-1 flexible connector for all high horsepower pumps, F-2 connector for fractional horsepower pumps.

3.02 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.04 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.

C. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

D. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

E. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, or piping resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

G. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the attention of the Owner's Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

H. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

I. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

J. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

K. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

L. Equipment Restraints:
   1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
   3. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction. Provide required submittals for components.

M. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet (12m) and longitudinal supports a maximum of 80 feet (24m).
   3. Brace a change of direction longer than 12 feet (3.7m).

N. Install cables so they do not bend across edges of adjacent equipment or building structure.

O. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction, providing required submittals for component.

P. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.

Q. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

R. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

S. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.05 VIBRATION ISOLATION OF PIPING

A. Horizontal Piping: The first three pipe supports from vibration isolated equipment must be vibration isolated. The static deflection of the pipe support isolators must be equal to the static deflection for the isolators under the connected equipment. Overhead piping shall suspend from Mason Type 30N spring hangers, or equal. Floor supported piping shall rest on Mason Type SLR isolators, or equal. Refer to contract drawings for additional vibration isolation requirements for piping. Where piping connects to plumbing equipment install Mason Type SFDEJ or SFU expansion joints or Mason Type FFL stainless hoses if Type SFDEJ or SFU is not suitable for the service.

B. Riser isolation: Risers that experience excessive thermal expansion shall be suspended from Mason Type 30N spring hangers or supported by Mason Type SLF(H) spring mountings, anchored with Mason Type ADA(H) anchors, and guided with Mason Type VSG(H) sliding guides. Horizontal pipe runs and branches shall be supported on Mason Type 30N spring hangers for the first three supports from the risers. Steel springs shall be selected to provide a minimum of 0.75"static deflection except in those expansion locations where additional deflection is required to limit load changes to ± 25% of the initial load. Submittals must include riser diagrams and calculations

showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.07 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

SECTION 22 05 49 - SEISMIC RESTRAINT FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SUMMARY

A. This Section includes the following:
   1. Seismic restraint and support of piping, ductwork and mechanical equipment as required by code and as designed by project registered professional Structural Engineer.
   2. Plumbing (mechanical) component supports and the means by which they are attached to the plumbing component shall be designed for the forces and displacements determined in ASCE 7 Chapter 13. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the plumbing component.

1.03 DEFINITIONS

A. AHJ: Authority Having Jurisdiction

B. ASCE: American Society of Civil Engineers

C. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

D. CBC: California Building Code with Amendments

E. IBC: International Building Code with Amendments

F. ICC-ES: ICC-Evaluation Service

G. Building Seismic Design Category: The directions of application of seismic forces used in the design shall be those which will produce the most critical load effects. Seismic Design Categories are classified as E. Refer to Structural Designs for project specific classification.

H. Mechanical Attachments: Means by which components or supports of nonstructural components are secured or connected to the seismic force-resisting system of the structure. Such attachments include anchor bolts, welded connections, and mechanical fasteners.

I. Mechanical Supports: Those members, assemblies of members, or manufactured elements, including braces, frames, legs, lugs, snubbers, hangers, saddles, or struts, and associated fasteners that transmit loads between nonstructural components and their attachments to the structure.

J. Mechanical Components: Elements, including, but not limited to, pumps, air handling units, boilers, chillers, pipes, ductwork, and exhaust fans.

K. Story Drift: The horizontal deflection at the top of the story relative to the bottom of the story.

1.05 RELATED WORK SPECIFIED ELSEWHERE

A. Section 22 0500: Basic Plumbing Materials and Methods

B. Section 22 0548: Vibration Isolation for Piping and Equipment

1.06 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Structural Performance: Restraint devices and systems shall withstand the effects of locally defined gravity loads, seismic loads, dead loads, live loads, winds loads and stresses within limits and under conditions indicated according to the Building Code and ASCE 7. Coordinate all support structures and restraint systems with project registered professional Structural Engineer.

C. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17A of the CBC, the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. Per CBC Chapter 17A all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner’s Representative.

D. Codes and Standards: Provide components conforming to the seismic load requirements of the latest addition of the local building code and the following:
   1. California Building Code with Amendments.
   2. International Building Code with State Amendments.

3. ASCE 7-16 (Latest Edition) - Minimum Design Loads for Buildings and Other Structures.
    a. Ductwork and piping requirements defined in Chapter 13 Seismic Design Requirements for nonstructural Components. Nonstructural components in Seismic Design Category A are exempt from seismic design requirements.
4. ASHRAE – Practical Guide to Seismic Restraint (Latest Edition).
5. Mason West Inc. - Seismic Restraint Guidelines (Latest Edition).
    a. For all suspended piping.

1.07 APPLICABILITY

A. Refer to building design criteria provided on Architectural and/or Structural Engineering designs for seismic design criteria including Occupancy Category, Risk Category, Seismic Design Category, Component Importance Factor and Short Period Design Response Acceleration Parameter as required to determine the type of seismic restraints.

B. Seismic restraints are required for nonstructural plumbing systems, but may not be required for the following conditions related to nonstructural components per CBC 1617A.1.18:
    1. Plumbing components in Seismic Design Categories D, E, or F facilities where all of the following apply:
        a. The component Importance Factor, I_p, is equal to 1.0.
        b. The component is positively attached to the structure.
        c. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and any of the following applies:
            1) The component weighs 400 lbs. (1,780 N) or less and has a center of mass located four feet (1.22 m) or less above the adjacent floor level; or
            2) The component weighs 20 lbs. (89 N) or less; or
            3) The distributed piping system weights 5 lbs./ft. (73 N/m) or less.

C. Additional Provisions for Piping and Tubing Systems per CBC 1617A.1.26 ASCE 7 Section 13.6.7.3:
    1. Design for the seismic forces of ASCE 7 Section 13.3 shall not be required for piping systems where flexible connections, expansion loops or other assemblies are provided to accommodate the relative displacement between components and piping, where the piping system is positively attached to the structure, and where any of the following conditions apply:
        a. Trapeze assemblies are supported by 3/8-inch or 1/2-inch diameter rod hangers not exceeding 12 inches in length from the pipe support point ot the connection at the supporting structure, and no single pipe exceeds the diameter limits set forth in item b.2 below or 2 inches where I_p is greater than 1.0 and the total weight supported by any single trapeze is 100 pounds or less; or
        b. Piping that has an R_p in ASCE 7 Table 13.6-1 of 4.5 or greater supported by rod hangers and provisions are made to avoid impact with other

structural or nonstructural components or to protect the piping in the event of such impact, or pipes with $I_p = 1.0$, supported by individual rod hangers 3/8-inch or 1/2-inch in diameter, where each hanger in the pipe run is 12 inches or less in length from the pipe support point to the connection at the supporting structure; and the total weight supported by any single hanger is 50 pounds or less. In addition, the following limitations on the size of piping shall be observed:

1) In structures assigned to Seismic Design Category D, E or F where I_p is greater than 1.0, the nominal pi pe size shall be 1 inch or less.
2) In structures assigned to Seismic Design Category D, E or F where I_p = 1.0, the nominal pipe size shall be 3 inches or less.

c. Pneumatic tube systems supported with trapeze assemblies suing 3/8-inch in diameter rod hangers not exceeding 12 inches in length from the tube support point to the connection at the supporting structure and the total weight supported by any single trapeze is 100 pounds or less.
d. Pneumatic tube systems supported by individual rod hangers 3/8-inch or 1/2-inch in diameter, and each hanger in the run is 12 inches or less in length from the tube support point of the connection at the supporting structure, and the total weight is supported by any single rod is 50 pounds or less.

2. Flexible connections in piping required in ASCE 7 Section 13.6.7.3 are not required where pipe is rigidly attached to the same floor or wall that provides vertical and lateral support for the equipment, or to a fixture.
3. Flexible connections in piping are required at seismic separation joints and shall be detailed to accommodate the seismic relative displacements at connections.

D. Seismically restrained systems shall not move more than 2” when pushed and shall not impact other nonstructural components or building structure. The design force of restraint elements shall be doubled (2 x Fp) to allow for movement up to 2” per ASCE 7.

1.08 PERFORMANCE REQUIREMENTS

A. Component Importance Factor and Risk Category:
1. Ip=1.0: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
2. Ip=1.5: Components and piping conveying toxic or explosive material, including natural gas, propane and fuel oil.
3. Ip=1.5: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category, or Hospitals and Correctional Treatment Centers. Components include, but are not limited to the following:
a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.

b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the AHJ and is sufficient to pose a threat to the public if released.

B. Mechanical Seismic Coefficients for Mechanical Components: Refer to ASCE 7 Table 13.6-1 for a_p factor (component amplification factor) and R_p factor (component response modification factor) as required for each unique mechanical component.

1.09 SUBMITTALS

A. Product Data:
1. Include rated load, rated deflection, and overload capacity for each device or system.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Submit seismic brace product details from the Mason West Seismic Restraint Guidelines detailing compliance with the specifications.
4. Where products from the Mason West Seismic Restraint Guidelines cannot be used, special details must be submitted for approval.

1.10 ENGINEERED PIPING SYSTEMS

A. Where the piping system design indicated on the plans utilizes Mason Industries, Inc. - Mason West, Inc. seismic restraint components, vibration isolators, guides, anchors, expansion compensators and flexible connectors the following requirements apply:
1. Mason Industries, Inc. - Mason West, Inc. products must be installed as shown.
2. If product substitutions or design changes are made the contractor must provide certified design of the piping system and meet the following conditions:
a. Certification must be provided by a registered professional Structural Engineer.
b. Certification shall include a statement that all systems have been checked for loads and stresses and that no excessive loads or stresses exist.
c. Forces on all anchors, guides, supports, and restraints must not exceed those shown in the original design unless the structure is checked for the larger loads at no cost to the owner.

1.11 MANUFACTURER AND CONTRACTOR RESPONSIBILITIES

A. All seismic restraints shall be designed by a registered professional Structural Engineer.

B. Seismic restraint layouts for piping shall be added to the contractor's shop drawings and shall include:
   1. The number, size and location of seismic braces.
   2. Maximum support loads and seismic loads at the seismic brace locations.
   3. Reference to specific details or pages from the Mason West Seismic Restraint Guidelines.

C. Installations not addressed by the state pre-approval process must be designed, detailed and submitted along with the shop drawings.

D. Submit seismic restraint layout drawings and special details for approval of the project registered professional Structural Engineer per the requirements listed in the Mason West Seismic Restraint Guidelines.

E. Seismic restraint layout drawings shall bear the stamp and signature of the registered professional Structural Engineer who designed the layout of the braces.

1.12 LOADS ON STRUCTURE

A. The responsibility of determining allowable loads on the structure is the sole responsibility of the project registered professional Structural Engineer.

B. Maximum support loads and seismic brace loads on the structure must be less than the maximum allowable loads defined by the project registered professional Structural Engineer, as shown on the plans.

C. Where maximum loads are not listed on the plans or the maximum allowable loads cannot be met, any additional support steel required to reduce support and seismic bracing loads on the structure shall be designed by the project registered professional Structural Engineer.

D. Mechanical component supports and the means by which that are attached to the component shall be designed for the forces and displacements determined in ASCI 7-16 Section 13.3.1 and 13.3.2. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the mechanical component.

E. Mechanical supports are those members, assemblies of members, or manufactured elements, including braces, frames, legs, lugs, snubbers, hangers, saddles, or struts, and associated fasteners that transmit loads between nonstructural components and their attachments to the structure.

F. Mechanical attachments are the means by which components or supports of nonstructural components are secured or connected to the seismic force-resisting system of the structure. Such attachments include anchor bolts, welded connections, and mechanical fasteners.

1.13 WARRANTY

1. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.
2. Refer to Section 22 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 INTENT

A. All seismic restraints described in this section shall be the product of a single manufacturer.

B. Mason Industries products are the basis of these specifications; products of other manufacturers may be submitted for review provided their systems strictly comply with the specifications.

2.02 SEISMIC SWAY BRACING

A. Seismic sway braces shall consist of galvanized steel aircraft cables, steel angles or steel struts, unless otherwise stated.

B. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads. Brace end connections shall be steel assemblies that swivel to the final installation angle.

C. Cable brace assemblies shall have published strength and stiffness ratings based on testing per FM-1950 standards.

D. Angle or strut bracket assemblies shall be FM Approved except as noted below.

E. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps.

F. Cable brace bracket assemblies shall be Type SCB or SCBH. Solid brace bracket assemblies shall be Type SSB-FM, SSBS-FM or SHB-FM. All bracket assemblies shall have published strength and stiffness values based on testing per FM-1950.

G. Rod clamps shall be Type SRC or UCC.

H. Hanging Cables with Adjustable Fastener: Wire rope hangers for maximum point loads not exceeding 100 lbs. (45 Kg) for supporting small pipes and equipment.
1. Wire Rope: High tensile steel wire rope, to ASTM 1023/1023M, class A zinc coating; 7 by 7 or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi (1,770 N per sq. mm); lengths, diameters, and wire construction to accommodate design loads and as indicated on Construction Shop Drawings.

2. Adjustable Fastener: Mild steel (type EN1A), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 100 lbs. (45 kg) (maximum per hanger).
3. Manufacturers: Gripple #Standard No. 2/3/4/5, Ductmate #Clutcher, or equal.

PART 3 - EXECUTION

A. Contractor's Statement of Responsibility: Each contractor responsible for installing a Designated Seismic System or any seismic resisting component must submit a statement of responsibility prior to the commencement of work to include acknowledgment of awareness of the need for Special Inspections.

B. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

C. Installation of seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

D. No connections between the piping and the building structure shall be made that degrades the seismic restraint system herein specified.

E. Any conflicts with other trades due to inadequate space or other unforeseen conditions should be brought to the attention of the Owner's Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

END OF SECTION

SECTION 22 05 93 - PLUMBING TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 WORK RELATED IN OTHER SECTIONS

A. Section 22 0500: Basic Plumbing Materials and Methods

B. Section 22 1000: Plumbing Piping, Valves and Specialties

C. Section 23 0593: Testing, Adjusting and Balancing (HVAC)

D. Section 23 0900: Building Automation System (BAS) Controls

E. Division 26: Electrical.

1.03 SUMMARY

A. Scope: Extent of testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section, and Section 22 0500 - Basic Plumbing Materials and Methods.

B. Systems: Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:
1. Domestic pressure booster systems.
2. Domestic hot water mixing valves.
3. Domestic cold and hot water pressure regulators.
4. Hands-free sensor operated flushometer valves and faucets.
5. Pressure regulating valves serving domestic.
6. Instruction of Owner's personnel for future balancing of systems.

1.04 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Reference Standards.

1. ANSI/ASHRAE Standard 111 - Measurement, Testing, Adjusting and Balancing of Building HVAC Systems (current edition).
2. ASHRAE - HVAC Applications Handbook: Chapter 38 - Testing, Adjusting and Balancing (current edition).
3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings, Chapter 6 (current edition).
4. AABC - National Standards for Total System Balance.
5. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
6. Local Nonresidential Energy Code.

C. Quality Assurance

D. Contractor's Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, is not the installer of the system to be tested and is otherwise independent of the project. Testing, adjusting, and balancing shall be performed by a certified NEBB technician or a certified AABC technician under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor. Testing and balancing agency must submit qualifications for review and approval prior to acceptance for work.

E. Penalty: The Contractor shall submit the name of the organization he proposes to employ for approval within 30 days after contract award. If the Contractor fails to submit the name of an acceptable agency within the specified time, a firm may be selected to accomplish the work, and this selection shall be binding upon the Contractor at no additional cost.

F. Retainages: In addition to any other sums retained or withheld pursuant to the provisions of this Contract, the amount of dollars will be withheld from payments to the contractor until such time as the work has been completed and accepted. In no event will this amount be paid to the Contractor prior to 60 days following acceptance of the project; during such time, the Contractor shall investigate and correct any reported deficiencies unless such deficiencies are a result of unauthorized tampering by building occupants.

G. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over six (6) months.

H. Testing and balancing agency, as part of its contract, shall act as authorized inspection agency responsible to Consulting Engineer and Owner, and shall list all items that are installed incorrectly, require correction, or have not been installed in accordance with contract Drawings and Specifications, pertaining to air distribution, cooling and heating systems. The testing and balancing agency is required to provide written reports of all

deficiencies and proposed recommendations to the Owner' Representative, Contractor, Architect and Engineer.

I. The testing and balancing agency shall provide with his bid a performance guarantee covering all phases of the work as herein specified.

J. The General and Plumbing Contractors shall cooperate with the selected testing and balancing agency in the following manner:
   1. Provide sufficient time before final completion dates so that tests and balancing can be accomplished.
   2. The various system installers, suppliers and contractors shall provide all required materials, labor and tools to make corrections when required without undue delay. Install balancing valves as required by testing and balancing agency.
   3. The contractor shall put the domestic hot recirculation system and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.
   4. Testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with a complete set of Record Drawings.
   5. The General Contractor shall make space and other facilities available to the testing and balancing agency to enable their work to progress. The General Contractor shall schedule the work of other trades to avoid conflicts with this work.

1.05 SUBMITTALS

A. Conform to the Submittals requirements of Division 01.

B. Forms: The Contractor shall deliver a complete copy of either NEBB or AABC standard forms for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are not acceptable.

C. Test Reports: Provide six (6) certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include key plans identifying location of all balancing valves and pumps. Final test reports shall be typed. Hand written reports are not acceptable.

D. Maintenance Data: Include, in maintenance manuals, copies of certified and approved test and balance reports and identification of instruments.

E. Qualifications: The Test and Balance Agency shall submit qualifications of all persons responsible for supervising and performing the on-site testing and balancing work and the name of the certifying engineer. Provide a reference list of five (5) similar size projects with contact person and telephone number.

1.06 AGENDA

A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.
   1. Review plans and specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.
   2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating and cooling.
   3. The agenda shall include a list of all domestic hot water flows to be performed at all mechanical equipment.
   4. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.

1.07 JOB CONDITIONS

A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.
   1. Installation and start-up work on equipment or systems to be tested has been completed and documented.
   2. Work area scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.
   3. All related mechanical systems which may affect the operation of the system to be tested shall be at their normal operating conditions.

PART 2 - PRODUCTS

2.01 TEST INSTRUMENTS

A. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. The Owner's Representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

B. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against Certified Calibrated instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.

PART 3 - EXECUTION

3.01 PROCEDURES AND INSTRUMENTS, GENERAL

A. Requirements: All systems and components thereof shall be adjusted to perform as required by approved project drawings and specifications.

B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four-hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.

C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.
   1. All instruments shall be applied in accordance with the manufacturer's certified instructions.
   2. All labor, instruments, and appliances required shall be furnished by the Contractor.

3.02 WATER SYSTEM PROCEDURES

A. Preparation:
   1. Open all valves to full open position.
   2. Check that pressure regulating valves are operational over full range.
   3. Check that hot water heaters are fully operational.
   4. Operate each variable frequency drive (VFD) and verify controls installation is complete.
   5. Check expansion tank(s) to determine they are not air bound and the system is completely full of water.

B. Metering: Water quantities and pressures shall be measured with calibrated meters.
   1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems.

C. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.

D. Distribution: Adjustment of distribution shall be effected by means of balancing valves and automatic flow control valves as provided. Manual service valves shall not be used for balancing.
   1. Where automatic flow control valves are utilized in lieu of manual balancing valves, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.

E. Water System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements:
   1. Set pressure regulators to not exceed 80 psi inside the building.
   2. Set pressure booster pumps and associated balancing valves to proper gallons per minute delivery.
   3. Set cold water and hot water pressure regulators to maintain the same pressure at remote fixtures within +/- 5 psi in all location throughout the water demand range.
   4. Test, verify and record operation of domestic water pressure booster systems.
   5. Upon completion of flow readings and adjustments at balancing valves, mark all settings and record data.

6. List all mechanical specifications of pumps.
7. Rated and actual running amperage of pump motor.
8. Adjust each pressure regulating valves and document final setpoint.

3.03 WATER SYSTEM DATA

A. Report: The certified report for reach water system shall include the data listed below.
   1. Pumps (Booster):
      a. Installation data
         1) Manufacturer and model
         2) Size
         3) Type drive
         4) Motor hp, voltage, phase, and full load amps
      b. Design data
         1) GPM
         2) Head
         3) RPM
         4) Amps
      c. Recorded data
         1) Discharge pressures (full-flow and no-flow)
         2) Suction pressures (full-flow and no-flow) operating head
         3) Operating gpm (from pump curves if metering is not provided) no-load
         4) Amps
         5) Full-flow amps
         6) No-flow amps
         7) Inlet temperature to each pump under normal operating conditions
   2. Water Heaters and Mixing Valves:
      a. Installation Data
         1) Manufacturer, model, and type
         2) Flow rate
         3) Inlet (entering) and outlet (leaving) temperatures
         4) Inlet (entering) and outlet (leaving) pressures
      b. Recorded Data
         1) Flow rate
         2) Entering and leaving water temperatures
         3) Entering and leaving pressures
      c. Domestic Water Service
      d. Recorded Data
         1) Incoming domestic water pressure from the serving utility upstream of all building pressure regulating valves with time and date
         2) Incoming domestic water temperature with time and date

3.04 SENSOR ACTIVATED FLUSHOMETER VALVES (TOILETS AND URINALS)

A. Verify that each hands-free sensor operated flushometer valve is operating properly. Adjust factory default settings as necessary, and as available, to prevent unnecessary

flushing and to allow for efficient flushing. Settings that may be adjusted include: user dwell time; flush delay; and user detection range.

1. Dwell time: should not be less than 7 seconds. Adjust to 10 seconds as necessary to limit excessive flushing cycles.
2. Flush delay: the delay when the person leaves the range to start a flush should not be less than 2 seconds. Adjust up to 5 seconds to limit excessive flushing cycles.
3. User detection range:
   a. Urinal: the user must be within 20” to activate a flushing cycle. Adjust from 15” to 36” as necessary to limit excessive flushing cycles.
   b. Toilet: the user must be within 30” to activate a flushing cycle. Adjust from 15” to 36” as necessary to limit excessive flushing cycles.

B. Recorded Data
1. Dwell time: Initial timing and final setpoint.
2. Flush delay: Initial timing and final setpoint.
3. User detection range: Initial activation range and final setpoint.

3.05 SENSOR ACTIVATED FAUCETS

A. Verify that each hands-free sensor operated faucet is operating properly during the hand washing cycle and limiting excessive water usage. Adjust factory default settings as necessary, and as available, though most faucets are factory preset and may not be adjustable. Settings that may be adjusted include: recognition range; after flow period; and maximum water flow period.
1. Recognition range: Should not be greater than 6” from sensor.
2. Maximum water flow period per cycle: Should not exceed 10 seconds.
3. Maximum after flow period after removing hands: Should not exceed 1 second.

B. Recorded Data
1. Recognition range: Initial activation range and final setpoint.
2. Maximum water flow period per cycle: Initial timing and final setpoint.
3. Maximum after flow period after removing hands: Initial timing and final setpoint.

3.06 TOLERANCES

A. Set domestic hot water flow rates within plus or minus 10 percent of specified flow rates.

3.07 CERTIFIED REPORTS

A. Submittals: Six (6) copies of the reports described herein final inspection.

B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.

C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and design deficiencies.

D. Certification: Certification shall include checking of adherence to agenda, of calculations, of procedures, and evaluation of final summaries.

END OF SECTION

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
   1. Piping Services:
      a. Domestic hot water supply and return.
      b. Roof and overflow roof drain piping and drain bodies. (See Drains below)
      c. Drains from electric water coolers to first connection.
      d. Cooling coil condensate drainage.
      e. All valves, separators, strainers and fittings for systems listed above.
   2. Roof Drains and Associated Piping: All roof and overflow drain bodies and associated piping are to be insulated except in Hot-dry and Mixed-Dry climate zones as defined by the National Renewable Energy Laboratory Building America zone map. See Pacific Northwest National Laboratory publication PNNL 17211, Guide to Determining Climate Regions by County.
   3. Types of plumbing piping insulation specified in this Section include the following:
      a. Pipe insulation: Fiberglass.
      b. Pipe insulation: Flexible elastomeric closed cell foam.
   4. Insulation jackets:
      a. Interior application
      b. Exterior application
      c. Removable covers
   5. Types of plumbing equipment insulation specified in this Section include the following:
      a. Flexible elastomeric closed cell foam.
      b. Fiberglass blanket
      c. Fiberglass board
      d. Cellular glass.
   6. Insulation accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 22 0500: Basic Plumbing Materials and Methods.

1.04 DEFINITIONS

A. Ambient: The air temperature to be maintained in a conditioned room, typically between 70□F and 78□F.

B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.

C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.

D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.

E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.

F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.

G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

H. Freezing Climate: Where outdoor design temperature is less than 34°F (1°C), as stated in ASHRAE Fundamentals under 99% column for winter design conditions.

1.05 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
      a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plat.
      b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
      c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
      d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission.
      e. Properties by Means of the Guarded-Hot-Plate Apparatus.
      f. C195 - Specification for Mineral Fiber Thermal Insulating Cement.
      g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
      h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
      i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.

j. C305 - Test for Thermal Conductivity of Pipe Insulation.
k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
m. C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
n. C449 - Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
o. C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation.
s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
w. C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
y. C1104 – Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
z. C1071 - Standard Specification for Thermal and Acoustical Insulation.
aa. C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
bb. D1667 – Standard Specification for Flexible Cellular Material-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
cc. E84 - Test Method for Surface Burning Characteristics of Building Materials.
dd. E119 - Test for Fire Resistance.
ee. G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
ff. G22 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
3. 90 Energy Conservation in New Building Design.
4. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
   a. 255 Test Methods, Surface Burning Characteristics of Building Materials.

B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

C. Products Containing Prohibited Chemicals:
   1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable:
      a. Pentabrominated diphenyl ether (CAS#32534-81-9)
      b. Octabrominated diphenyl ether (CAS#32536-52-0)
      c. Decabrominated diphenyl ether (CAS#1163-19-50

D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

E. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
   1. Test Specimen: Two specimens shall be used, each measuring 1” by 4” by approximately 1/2” thick.
   2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1” wide, 4” long and 0.020” thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
   3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.

F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory. Submit samples.

B. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
   1. Pentabrominated diphenyl ether (CAS#32534-81-9)
   2. Octabrominated diphenyl ether (CAS#32536-52-0)
   3. Decabrominated diphenyl ether (CAS#1163-19-50

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.08 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 22 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.02 PIPE INSULATIONS (IDENTIFIED BY KEY CODE PI)

A. PI-A, Preformed Mineral Wool or Fiberglass:
   1. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. UL 723 or ASTM E84 compliant for Flame Spread Index of 25 or less and Smoke Developed Index of 50 or less. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
   2. Non-Wicking.
   3. Applications: Insulation of piping up to 18” in diameter and 3” thick insulation.
   4. 'K' Value: 0.23 at 75°F.
   5. Maximum Service Temperature: 850°F.

6. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.
7. Manufacturers: Johns Manville #Micro-Lok HP, Owens Corning #SSL II, Knauf, einsulation, or equal.

B. PI-B, Flexible Closed-Cell Elastomeric or Neoprene:
1. Closed-cell, halogen free, elastomeric insulation.
2. Comply with ASTM-C177, ASTM E 84 and UL 181.
3. 'K' Value: 0.27 Btu•in./(hr•ft²•ºF) at 75°F.
4. Density: 3.0 to 6.0 lbs./cu.ft.
5. Maximum Service Temperature: 260°F.
6. Seal all seams and joints with contact adhesive.
7. Manufacturers: Armacel #AP Armaflex, Rubatex #K-Flex ECO, Aeroflex #Aerocel, or equal.

C. PI-C, Rigid Closed-Cell Cellular Glass:
1. Comply with ASTM C522.
2. 'K' Value: 0.34 Btu•in./(hr•ft²•ºF) at 140°F (60°C).
3. Density: 8.0 lbs./cu. ft.
4. Maximum Service Temperature: 900°F.
5. Manufacturers: Pittsburgh-Corning #Foamglas with Pittwrap jacketing, or equal.

D. PI-D, Flexible High Temperature Aerogel:
1. High performance flexible insulation for specialty insulation applications with reduced available space for traditional insulation materials or higher thermal performance is required.
2. Compliant with ASTM C177, C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763, and E84.
3. 'K' Value: 0.12 Btu•in./(hr•ft²•ºF) at 212°F (100°C). Thickness as required to meet energy code requirements.
4. Density: 10.7 lbs./cu. ft. (0.16 g/cc)
5. Maximum Service Temperature: 392°F (200°C).
6. Water Absorption, % of volume: <5% (maximum).
7. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
8. Manufacturer: Pacor #Pryogel 2250.

2.03 EQUIPMENT INSULATIONS (IDENTIFIED BY KEY CODE EI)

A. EI-A: Flexible Fiberglass Blanket:
1. Johns Manville Microlite Type 75 Flexible Blanket:
2. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.
3. Maximum Service Temperature: 250°F.
4. Density: 0.75 lb/cu ft.

5. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. EI-B, Rigid Fiberglass Board:
1. Johns Manville Spin-Glass 814
2. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
3. Maximum Service Temperature: 250°F.
4. Density: 3.0 lb/cu ft.
5. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
6. Facing: 1” galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

C. EI-C, Rigid Closed Cell Cellular Glass:
1. Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation.
2. 'K' Value: 0.35 at 75°F.
3. Density: 8.0 lb/cu. ft.
4. Maximum Service Temperature: 900°F.

D. EI-D, Flexible Closed-Cell Elastomeric or Polyethylene:
1. Armacel AP Armaflex, Rubatex K-Flex ECO, Aeroflex Aerocel, closed-cell, halogen free, elastomeric insulation. Comply with ASTM-C177, ASTM E 84 and UL 181.
2. ‘K’ Value: 0.27 at 75°F.
3. Density: 3.0 to 6.0 lbs./cu.ft.
4. Maximum Service Temperature: 260°F.
5. Seal all seams and joints with contact adhesive.

E. EI-E, Rigid Hydrous Calcium Silicate
1. Johns Manville, IIG Thermo-12/Gold Meeting ASTM C533; Rigid Molded Block; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
2. 'K' Value: 0.40 at 300°F.
3. Maximum Service Temperature: 1,200°F.
4. Compressive Strength (block): Minimum of 200 psi to produce 5% compression, based on 1-1/2" thickness.
5. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½" x .015" galvanized steel bands on 12” maximum centers for large areas.

F. EI-F, Flexible High Temperature Aerogel:
1. High performance flexible insulation for specialty insulation applications with reduced available space for traditional insulation materials or higher thermal performance is required.
2. Compliant with ASTM C177, ASTM C1728, ASTM C165, ASTM C1101/1101M, ASTMC1104/1104M, ASTM C1336, ASTM C1617, ASTM C1763, and ASTM E84.
3. 'K' Value: 0.12 Btu•in./(hr•ft²•ºF) at 212°F (100°C). Thickness as required to meet energy code requirements.
4. Density: 10.7 lbs./cu. ft. (0.16 g/cc)
5. Maximum Service Temperature: 392°F (200°C).
6. Water Absorption, % of volume: <5% (maximum).
7. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
8. Manufacturer: Pacor #Pryogel 2250.

G. EI-G, Fire Barrier Plenum Wrap for encapsulating non-rated (plastic) pipes and cables:
1. High-temperature, flexible, blanket insulation with FSK jacket that is NRTL (Nationally Recognized Test Lab) tested and certified. Apply one layer blanket to wrap combustible items in an air plenum area.
2. Density (minimum): 8 lb./cu.ft.
3. Thickness (minimum): 0.5” thick (13 mm).
4. Maximum operating temperature: 2300°F (1260°C).
5. Flame spread index: ASTM E84, less than 25.
6. Smoke developed index: ASTM E84, less than 50.
7. Manufacturer: 3M #Fire Barrier Duct Wrap 5A+, Unifrax #FyreWrap 0.5 Plenum Insulation, Morgan #FireMaster PlenumWrap or equal.

2.04 JACKETING MATERIALS

A. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of pipes.
2. PVC Plastic: One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape. Not allowed in ceiling return air plenums or other areas requiring flame/smoke spread rating less than 25/50. Manufacturers: Johns Manville Zeston 2000 or equal.
3. Canvas Jacket: UL listed fabric, 6 oz/sq. yd. plain weave cotton, treated with dilute fire retardant lagging adhesive.
4. Aluminum Jacket: 0.016” thick sheet, smooth or embossed] finish, with longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner. Secure aluminum jackets with 3/8” or 1/2” stainless steel bands on 12” centers.

B. Field Applied Jackets (For Exterior Applications):
1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.

2. Aluminum Jacket: 0.016” (minimum) thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner.
3. Stainless Steel Jacket: Type 304 stainless steel, 0.010” minimum (smooth/corrugated) finish.
4. Secure stainless steel or aluminum jackets with 3/8” or 1/2” stainless steel bands on 12” centers.
5. Manufacturers: Pabco, Childers, RPR, or approved equal.

C. Removable Covers:
1. Provide removable covers on pumps, backflow devices, valves greater than 2”, flanges, strainers, etc., where periodic maintenance or removal of insulation may is required.
2. Use of pre-molded fittings with PVC covers is acceptable, unless noted otherwise.
   a. Cold systems: Provide PVC covers on elbows.
   b. Cold systems: Provide Armaflex elastomeric foam for flanges, valves, pumps and strainers.
   c. Hot systems: provide PVC covers on elbows and flanges.
   d. Hot Systems: provide removable blanket covers on valves, pumps, and strainers.
3. Removable- type silicon cloth fiberglass filled insulating blankets:
   a. 0-350°F service operating temperature.
   b. Jacket: silicon impregnated fiberglass cloth.
   c. Liner: silicon impregnated fiberglass cloth.
   d. Liner reinforcement: stainless steel mesh cloth.
   e. Insulation: 1” type E glass matt, minimum.
   f. Fastening: 2” nomex Velcro, 1” straps and stainless steel D-rings, or 12-gauge stainless steel hooks and stainless steel wire.
   g. Thread: Kevlar/stainless steel thread.
   h. Manufacturers: Fit Tight Covers, GLT products, or equal custom fabrication by Insulation Contractor.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.02 INSTALLATION

A. General:
1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Continue insulation and vapor barrier at penetrations and supports, except where prohibited by code.

B. Piping Insulation:
1. Locate insulation and cover seams in least visible locations unless otherwise specified.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Insulate all hot water and cold water pipes as defined in the following tables.
4. Provide vapor retardant jackets on all insulated dual temperature pipes and cold pipes, and drain pipes, conveying fluids below 60°F with self-sealing laps. Insulate complete system. No staples shall be used on pipes conveying fluids below ambient temperatures (cold systems).
5. For insulated pipes conveying fluids above 105°F, secure jackets with self-sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
6. Provide insert between support shield and piping on piping 1-1/2” diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   a. 1-1/2" to 2-1/2" pipe size 10" long
   b. 3" to 6" pipe size 12" long
   c. 8" to 10" pipe size 16" long
   d. 12" and over 22" long
7. Use of metal saddles is acceptable as specified in Section 220500. Fill interior voids with segments of insulation matching adjoining pipe insulation.
8. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.

9. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers.
10. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.
11. Cold systems: Provide Armaflex elastomeric foam for pumps and strainers.
12. For insulated pipes exposed inside the building in corridors, offices, conference room, lobbies and similar occupied spaces cover the insulation with Johns Manville Zeston 2000 PVC jacket and fitting covers.
13. Insulate all sanitary sewer pipes and drainage fixture bodies where piping is located above food preparation, food handling and patient healthcare areas conveying fluids below 60°F.
14. For exterior applications:
    a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
    b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.
15. For underground installations, install per manufacturer's written instructions and recommendations.
16. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

C. Equipment Insulation:
1. See Piping Insulation above for additional requirements.
2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer’s recommendations.
3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.
5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.
7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.

8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

3.03 ENCAPSULATING NON-RATED PIPES AND CABLES

A. Where combustible non-fire rated pipes (plastic) and cables are installed in an air plenum space provide one layer of EI-G fire barrier plenum wrap to fully encapsulate the item to comply with ASTM E84 or UL-723.

3.04 PIPING INSULATION SCHEDULE

A. Table 1: Piping Services, fluid temperature, and insulation type required.
1. All insulation thicknesses shall meet or exceed State Energy Code requirements as noted below. Increase thickness 1/2" if exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.

INSULATION INDEX	
INSULATION KEY CODE	INSULATION TYPE
PI-A	Preformed Mineral Wool or Fiberglass
PI-B	Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene
PI-C	Rigid Closed-Cell Cellular Glass
PI-D	Flexible High Temperature Aerogel:
EI-A	Flexible Fiberglass Blanket
EI-B	Rigid Fiberglass Board
EI-C	Rigid Closed-Cell Cellular Glass
EI-D	Flexible Closed-Cell Elastomeric or Polyethylene
EI-E	Rigid Hydrous Calcium Silicate
EI-F	Flexible High Temperature Aerogel

TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED			
SERVICE	PIPE SIZE (inches)	THICKNESS (inches)	MATERIAL OPTIONS
Domestic hot water supply and return.	All Sizes	Refer to Applicable Energy Code, one inch minimum.	**PI-A or PI-B**. Refer to Applicable Energy Code and Table 2 below.
Domestic hot water supply and	All sizes	1	**PI-D**. Refer to Applicable

TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED			
SERVICE	PIPE SIZE (inches)	THICKNESS (inches)	MATERIAL OPTIONS
return, and other services, only where space is restricted and other insulation materials won't fit.			Energy Code and Table 2 below.
Roof and overflow roof drainage piping.	All sizes	1	**PI-A or PI-B.** See sub-sections below for re-quired locations.
Roof and overflow drain bodies.	All sizes	1	**PI-A or PI-B.** See sub-sections below for re-quired locations.
Heat-Traced liquid containing piping exposed to freezing.	All Sizes	1-1/2	**PI-A or B**. Provide alu-minum jacket and label "heat traced" along with service designator label
Misc. drains from electric water coolers, ice machines, etc.	All Sizes	1	**PI-A or B**
Sanitary drain pipes and fixture bodies located above food ser-vice areas conveying fluid below 60°F.	All Sizes	1	**PI-A or B**
Cooling coil condensate drain piping and traps located inside spaces within the building, and above ceilings and in attics.	All Sizes	1/2	**PI-A or B.** Coordinate with Division 23.
Cooling coil condensate drain piping and traps located inside the building, in mechanical rooms located in buildings locat-ed in humid climates defined as "A-Moist" or "C-Marine" in the IECC.	All Sizes	1/2	**PI-A or B.** Coordinate with Division 23.
Cooling coil condensate drain piping and traps located out-doors.	N/A	N/A	**Not required.**

B. Table 2: Code Minimum piping insulation thickness based on fluid temperature and piping size
   1. California
      a. Insulate all domestic hot water piping to the more stringent requirements found in Section 609.11 of the California Plumbing Code and the California T-24 Energy Code.

b. Additional minimum pipe insulation table based on California T-24 Energy Code Table 120.3-A as follows:

TABLE 2
INSULATION BASED ON CALIFORNIA T-24 ENERGY CODE TABLE 120.3-A
MINIMUM PIPE INSULATION THICKNESSES OR GREATER

FLUID TEMPERATURE RANGE (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)				
			Less than 1	1 to 1-1/2	2 to 3	4 to 6	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)				
Space heating systems (steam, steam condensate and hot water) and Domestic Services Water Heating Systems							
Above 350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.31	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.22-0.28	100	1.0	1.5	2.0	2.0	2.0
Space cooling systems (chilled water, refrigerant and brine)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
Below 40	0.20-0.27	75	1.0	1.5	1.5	1.5	1.5

3.05 ROOF AND OVERFLOW DRAINAGE PIPE INSULATION (BUILDING INTERIOR)

A. Inside conditioned buildings, where roof and overflow bodies and piping are exposed, insulate all exposed roof drainage (primary and overflow) piping, horizontal and vertical.

B. In Freezing Climate zones insulate all concealed roof and overflow drain bodies and piping (horizontal and vertical) above grade.

C. In Non-Freezing Climate zones insulate all concealed roof and overflow drain bodies and roof drainage (primary and overflow) piping located within 20 feet, minimum, of the drain bodies. Also, insulate additional horizontal roof drainage (primary and overflow) piping, above grade, which extends beyond the 20 foot minimum, as necessary to minimize condensation potential.

D. Roof drainage piping strategically installed inside insulated walls, roof or ceiling construction may not require additional insulation as deemed appropriate by the Owner's Representative.

END OF SECTION

SECTION 22 10 00 - PLUMBING PIPING, VALVES AND SPECIALTIES

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to the following:
   1. Pipe and Fittings
      a. Sanitary waste and vent
      b. Rainwater drain and overflow
      c. Potable Cold water
      d. Potable Hot water
   2. Valves
      a. Water valves
      b. Backflow prevention valves
      c. Pressure reducing valves
      d. Thermostatic mixing valves
      e. Solenoid valves
   3. Water meters
   4. Thermometers and gauges
   5. Piping specialties
   6. Pipe escutcheons
   7. Strainers
   8. Drip pans
   9. Air vent
   10. Dielectric unions
   11. Unions
   12. Flanges
   13. Pipe sleeves
   14. Sleeve seals
   15. Valve boxes
   16. Pipe coating

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 22 0500: Basic Plumbing Materials and Methods, including:
   1. Hangers and supports.

2. Roof flashings.
3. Water hammer arrestors.
4. Trap primers.
5. Cleanouts.
6. Access panels.
7. Identification.

B. Section 22 3000: Plumbing Equipment.

C. Section 22 4000: Plumbing Fixtures.

D. Division 21: Fire Suppression.

E. Division 26: Electrical.

F. Division 09: Finishes/Painting.

1.04 FIRE PROTECTION VALVES:

A. Refer to Section 21 1000.

1.05 REFERENCE STANDARDS

A. Comply with requirements of latest standard or as required by local AHJ.

B. American National Standards Institute (ANSI)/American Welding Society (AWS):
1. ANSI/AWS A5.8: Specification for Filler Metals for Brazing.
2. ANSI/AWS A5.31: Specification for Fluxes for Brazing and Braze Welding.
3. ANSI/AWS B2.2: Standard for Brazing Procedure and Performance Qualification.
4. ANSI/AWS C3.4: Specification for Torch Brazing.
5. ANSI/NSF 14: Plastics Piping System Components and Related Materials.

C. American National Standards Institute (ANSI)/American Water Works Association (AWWA):
1. ANSI/AWWA A21.10: Ductile-Iron and Gray-Iron Fittings.

D. American Society of Mechanical Engineers (ASME):
1. ASME Boiler and Pressure Vessel Code.
2. ASME B1.20.1: Pipe Threads, General Purpose.
3. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
5. ASME B16.23: Cast Copper Alloy, Solder-Joint, DWV Drainage Fittings.
6. ASME B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150 and 300.
7. ASME B16.29: Wrought Copper, and Wrought Copper Alloy Solder-Joint Drainage Fittings, DWV.
8. ASME B16.26: Cast Copper Alloy Fittings for Flare Copper Tubes.

9. ASME B16.50: Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.
10. ASME B16.51: Cast and Wrought Copper and Copper Alloy Press-Connect Pressure Fittings.
11. ASME A112.6.4: Roof, Deck, and Balcony Drains.

E. American Society for Testing and Materials (ASTM):
1. Mechanical Couplings: ASTM A 536, ductile iron, or ASTM A 47, malleable iron coupling housing fabricated to manufacturer's specifications.
2. ASTM B584: Cast Copper Alloy for Grooved-End Fittings.
3. ASTM B75: Seamless Copper Tube for Grooved-End Fittings.
4. ASTM B32: Standard Specification for Solder Metal.
5. ASTM B88: Standard Specification for Seamless Copper Water Tube.
6. Hard Copper Tube: (Drawn Temper):
    a. ASTM B75: UNS Number C12200, drawn temper, seamless copper tube, wall thickness as specified.
    b. ASTM B88: Types K, L, and M, drawn temper, seamless copper tube.
    c. ASTM B306: Type DWV, drawn temper, seamless copper tube.
    d. ASTM B819: Type K and L, drawn temper, seamless copper tube.
7. Soft Copper Tube:(Annealed Temper):
    a. ASTM B75: UNS Number C12200, annealed temper, seamless copper tube, wall thickness as specified.
    b. ASTM B88: Types K and L, annealed temper, seamless copper tube.
    c. ASTM B280: Type ACR, annealed temper, seamless copper tube.
8. ASTM B306: Copper Drainage Tube (DWV):
9. ASTM B584: Copper Alloy Sand Castings for General Applications.
10. ASTM B813: Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
11. ASTM B828: Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
12. ASTM D3311: Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
13. ASTM A47: Ferritic Malleable Iron Castings.
14. ASTM A536: Ductile Iron Castings.
15. ASTM D1784: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
16. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
17. ASTM F2014: Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications.
18. ASTM F2389: Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems.
19. ASTM F2618: Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems.
20. ASTM F441: Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

21. ASTM F493: Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

F. American Society of Plumbing Engineers (ASPE)/American National Standards Institute (ANSI):
1. ASPE/ANSI 45: Siphonic Roof Drainage.

G. Cast Iron Soil Pipe Institute (CISPI):
1. CISPI 301: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications (ASTM B 888)
2. CISPI 310: Specification for Coupling for Use in Connection with Hubless Cast iron Soil Pipe and Fittings for Sanitary and Storm Drain Waste, and Vent Piping

H. Factory Mutual (FM):
1. FM-1680: Standard to evaluate intended application for long-term connection to hubless cast iron soil pipe aboveground and underground. Class I for Industrial/Commercial and Residential to 15 psi working pressure.

I. Joining Materials
1. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment.
   a. ASME B16.21, nonmetallic, flat, asbestos-free, full-face type for Class 150 and 300 cast copper alloy flanges. 1/8-inch maximum thickness, except where thickness or specific material is indicated.
2. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment.
   a. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.
3. Proprietary filler metals having compositions not conforming to the exact ANSI/AWS A5.8 classifications for BCuP and BAg Series filler metals shall be permitted when used according to the manufacturer's written instructions.
4. Soldering and Brazing Fluxes: Soldering and brazing fluxes shall not exceed 0.20 percent Lead (Pb) content for any work in potable water systems.
   a. Soldering Fluxes: ASTM B813, liquid or paste type.
   b. Brazing Fluxes: ANSI/AWS A5.31, Type FB3-A or FB3-C.
   c. The use of brazing flux is not necessary if the components being joined are wrought copper tube, wrought copper fittings and the filler metal being used is of the BCuP series.
5. ASTM B32 Solder Filler Metal:
   a. Alloy Sn95 or Alloy Sn94: Tin (Sn) approximately 95%, and Silver (Ag) approximately 5%, having 0.10% maximum Lead (Pb) content.
   b. Alloy Sb5: Tin (Sn) 95%, and Antimony (Sb) 5%, having 0.20% maximum Lead (Pb) content.
   c. Alloy E: Tin (Sn) approximately 95%, and Copper (Cu) approximately 5%, having 0.10% maximum Lead (Pb) content.

6. ANSI/AWS A5.8 Brazing Filler Metals:
   a. BCuP Series: Copper-Phosphorus alloys. The following brazing filler metals shall be used. Brazing filler metals shall conform to the requirements of the individual piping systems.
      1) BCuP - 2: Copper (Cu) and Phosphorus (P) 7.0 - 7.5%.
      2) BCuP - 3: Copper (Cu), Phosphorus (P) 5.8 - 6.2%, and Silver (Ag) 4.8 - 5.2%.
      3) BCuP - 4: Copper (Cu), Phosphorus (P) 7.0 - 7.5%, and Silver (Ag) 5.8 - 6.2%.
      4) BCuP - 5: Copper (Cu), Phosphorus (P) 4.8 - 5.2%, and Silver (Ag) 14.5 - 15.5%.

1.06 QUALITY ASSURANCE

A. Manufacturers Qualifications:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:
   1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
   2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
   3. Perform all tests required by governing authorities and as required under all Division 22 Sections. Provide written reports on all tests.
   4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
   5. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
   6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
   7. Provide thermostatic mixing valves and fixtures conforming to ASSE 1070 to limit the maximum water temperature to 110°F for all public lavatories and 120°F for all other public fixtures served with hot water. Handle position stops and temperature mixing valves shall be used as required to limit maximum temperature to prevent scalding. Water heater thermostats shall not be considered a suitable control.

C. All materials (such as piping, insulation, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 or UL 723. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified elsewhere in the

construction drawings. Contractor shall review all mechanical and architectural plans and be fully aware of all building design criteria prior to installation of any work. Any work installed that does not comply with applicable life/safety requirements of all codes and standards shall be replaced and/or repaired at no additional cost to the Owner. (Note to Editor: In the event a contractor inadvertently installs a non-compliant material in an unducted return air plenum space it may be possible to wrap the offending material in a smoke safe covering. There are treated PVC jackets available that meet the 25/50 rating. Check www.speedlinepvc.com as one resource for resolving these problems. Or, provide fiberglass pipe insulation as defined in specification Section 220700.)

D. Welding Standards:
   1. Welding Qualifications:
      a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.
   2. Welding Procedures:
      a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.
      b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."

E. Pressure Piping Standards
   a. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.
   b. Comply with ASME B31.9 Building Services Piping standard for the following services:
      1) Conveying fluid between 0°F (-18°C) to 250°F (121°C).
      2) Fluid pressure less than 350 psig.
   c. Comply with ASME B31.3 Process Piping standard for the following services:
      1) Conveying fluid above 250°F (121°C).
      2) Toxic or flammable fluids.

1.07 DEFINITIONS

A. AHJ: Authority Having Jurisdiction

B. CSA: Formerly known as the Canadian Standards Association (CSA). CSA Group is a member of ISO. CSA is accredited by US OSHA as a Nationally Recognized Testing Laboratory (NRTL).

C. Lead Free: Materials containing not more than 0.2 percent lead when used with respect to solder and flux and not more than a weighted average of 0.25 percent when used with respect to the wetted surfaces of pipes and pipe fittings, plumbing fittings, and fixtures, providing a specified definition and formula for determining “weighted average”.

D. NRTL: Nationally Recognized Testing Laboratory, including UL, CSA and/or ETL.

1.08 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.

B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

1.09 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for all piping, valves and specialties indicating dimensions, valve CV, tolerances etc.

B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverts. Indicate all footings and grade beams.
   1. For siphonic roof drainage system. Include calculations, plans, elevations and details.

C. Maintenance Data: Submit maintenance instructions on accordance with requirements of Division 01.

D. Delegated-Design Submittal for each vibration isolation and seismic-restraint device.
   1. Seismic restraint calculations must be provided for all connections to the structure.
   2. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
   4. Provide flexible joints, supports and piping joints as required to accommodate movement across seismic expansion joints and vertical building drift between floors.

1.10 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 22 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
   1. All pipe, pipe fittings and valves shall be manufactured in North America, or may be import products where manufacturers are specifically identified below. Alternatives may be acceptable, but must be submitted and approved by the Owner’s Representative prior to bidding. OR
   2. Upon request, the Owner’s Representative shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.

B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.

C. For all Grade B piping specified belowground provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.

D. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturer's names used herein, unless specifically noted that substitutes are not allowed.

2.02 STANDARD PIPE AND FITTING

A. Domestic Water Pipe & Fittings (Underground):
   1. Seamless copper tube, pipe sizes 1/2” to 8”:
      a. ASTM B88 or B75, Type K, annealed (soft) temper.
      b. ASTM B88 or B75, Type K, hard temper.

2. Fittings-Brazed:
   a. ASME B16.50 wrought or copper alloy.
3. Joints-Brazed:
   a. ANSI/AWS A5.8 filler metals.
   b. Manufacturer: Canfield #Sil-Can 5 or #Sil-Can 15, or equal.
4. For all piping installed underground wrap pipe with two layers of 20 mil PVC tape, minimum 2” wide, with 50% overlap and no exposed pipe surface. Manufacturer: 3M Scotchrap #51, Pasco Specialty #9000 Series, or equal.

B. Domestic Hot and Cold Water Pipe & Fittings and Pumped Systems (Aboveground):
1. Seamless copper tube, pipe sizes 1/2” to 8”:
   a. ASTM B88 or B75, Type K or L, annealed (soft) temper.
   b. ASTM B88 or B75, Type K or L, hard temper.
2. Fittings-Soldered:
   a. ASME B16.22 wrought copper alloy.
   b. ASME B16.18 cast copper alloy.
3. Fittings-Brazed:
   a. ASME B16.50 wrought or copper alloy.
4. Joints-Soldered:
   a. ASTM B32 filler metals. Manufacturers: Canfield #Silverflo or #Watersafe, Lucas Milhaupt #Silvabrite 100, or equal.
   b. Water soluble, lead free flux. Manufacturers: Oatey #H-20-95, JW Harris #Bridgit, La-CO #FLUX-RITE 90, Rectorseal #Nokorode, LucasMilhaupt #Silvabrite 100 or #95/5, or equal.
5. Joints-Brazed:
   a. ANSI/AWS A5.8 filler metals. Manufacturer: Canfield #Sil-Can 5 or #Sil-Can 15, LucasMilhaupt #Sil-Fos, or equal.
   b. Water soluble, lead free flux. Manufacturers: JW Harris #Safety-Silv, LucasMilhaupt #Handy Flux, or equal.

C. Condensate and Indirect drains (Gravity Flow):
1. Seamless copper tube, pipe sizes 1/2” to 8”:
   a. ASTM B88 or B75, Type L, annealed (soft) temper.
   b. ASTM B88 or B75, Type M or L, hard temper.
2. Fittings-Soldered:
   a. ASME B16.22 wrought copper alloy.
   b. ASME B16.18 cast copper alloy.
3. Fittings-Brazed:
   a. ASME B16.50 wrought or copper alloy.
4. Joints-Soldered:
   a. ASTM B32 filler metals. Manufacturers: Canfield #Silverflo or #Watersafe, Lucas Milhaupt #Silvabrite 100, or equal.
   b. Water soluble, lead free flux. Manufacturers: Oatey #H-20-95, JW Harris #Bridgit, La-CO #FLUX-RITE 90, Rectorseal #Nokorode, LucasMilhaupt #Silvabrite 100 or #95/5, or equal.

2.03 PIPE COATINGS AND WRAPPING

A. Pipe coatings and/or wrapping may be required for certain pipe materials where pipes are buried in corrosive soils or located in corrosive air environments. Verify local soil and air conditions with building department and engineered soils report, when available. Protect all underground buried steel and copper pipe and fittings. Protect all aboveground exposed steel and copper pipe and fittings located in corrosive air environments. Buried cast iron does not require protection unless specifically required by the AHJ or project engineered Soils Report.

B. Provide buried pipe protection using one of the following tape methods:
   1. Wrap pipe with two layers of 20 mil PVC tape, minimum 2” wide, with 50% overlap and no exposed pipe surface.
   2. Or, cover with pre-fabricated extruded plastic cover with joints sealed with two layers of 20 mil PVC tape.
   3. Manufacturers: 3M Scotchrap #51, Pasco Specialty #9000 Series, or equal.

C. Provide buried pipe protection using one of the coating following methods:
   1. Apply general purpose black asphalt paint to exposed buried piping to prevent corrosion. All surfaces should be clean, dry, and free of oil, grease, dirt, loose paint, or other foreign matter. Brush or spray coating at a rate of 1 to 1.5 gallons per 100 sq.ft.
   2. Manufacturers: Karnak #118, or equal.

D. Furnish corrugated stainless steel tubing (CSST) with factory-applied corrosion–resistant polyethylene jacket for use in corrosive atmosphere. Coating properties include the following:
   1. Gastite corrugated stainless steel tube jacket shall be UV-Resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density.

2.04 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.

B. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer’s figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer’s assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

5. Joints-Brazed:
   a. ANSI/AWS A5.8 filler metals. Manufacturer: Canfield #Sil-Can 5 or #Sil-Can 15, LucasMilhaupt #Sil-Fos, or equal.
   b. Water soluble, lead free flux. Manufacturers: JW Harris #Safety-Silv, LucasMilhaupt #Handy Flux, or equal.
6. Insulate condensate drain pipes with minimum 1/2" insulation to prevent moisture dripping from pipe.

D. Trap Primer Piping:
1. Seamless copper tube:
   a. ASTM B88 or B75, Type K, annealed (soft) temper.
2. Fittings (underground):
   a. No joints allowed underground or bottom slab level.
3. Fittings (aboveground):
   a. ASME B16.22 wrought copper alloy.
   b. ASME B16.18 cast copper alloy.
4. Joints-Soldered:
   a. ASTM B32 filler metals. Manufacturers: Canfield #Silverflo or #Watersafe, Lucas Milhaupt #Silvabrite 100, or equal.
   b. Water soluble, lead free flux. Manufacturers: Oatey #H-20-95, JW Harris #Bridgit, La-CO #FLUX-RITE 90, Rectorseal #Nokorode, LucasMilhaupt #Silvabrite 100 or #95/5, or equal.
5. For all copper piping installed underground wrap pipe with two layers of 20 mil PVC tape, minimum 2” wide, with 50% overlap and no exposed pipe surface. Manufacturer: 3M Scotchrap #51, Pasco Specialty #9000 Series, or equal.

E. Sanitary Sewer, Vent, Rainwater Pipe & Fittings up to 15”:
1. Pipe and Fittings: Cast iron, bituminous coated or epoxy coated with “No-Hub” fittings complying with ASTM A74, ASTM A888, CISPI 301. Manufactured by AB&I, Charlotte, Tyler, New Age or equal.
2. Couplings Underground: Heavy Duty Type 301 or 304 stainless steel couplings conforming to ASTM C1540 with heavy-duty shield and neoprene sealing sleeve conforming to ASTM C564, CISPI 301 and FM-1680. Minimum four bands up to 4” diameter and six bands for 5” and larger diameters. Manufacturer: Anaco Husky #SD-4000, Clamp-All (Norma Group) #Hi-Torq 125, Mission #HeavyWeight, Ideal Tridon #HD, or equal.
3. Couplings Aboveground: Type 301 or 304 stainless steel couplings conforming to ASTM C1540 with heavy-duty shield and neoprene sealing sleeve conforming to ASTM C-564, CISPI 310 and FM-1680. Manufacturer: Anaco Husky #HD-2000, Clamp-All (Norma Group) #Hi-Torq 80, Mission #HeavyWeight, Ideal Tridon #MD, or equal.

2.03

D. Acceptable manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
   1. Gate, Ball, Check: Apollo, Hammond, Nibco (commercial grade, US manufacturer only), Milwaukee, Victaulic, Watts or equal.
   2. Lubricated Plug Valves: Homestead, Resun, Rockwell, or equal.
   3. Backflow Preventors: Apollo, Ames, Febco, Cla-Val, Watts, Wilkins, or equal.
   4. Pressure Reducing Valves: Apollo, Cash-Acme, Cla-Val, Watts, Wilkins, or equal.
   5. Solenoid Valves: ASCO, Automatic, Magnatrol, or equal.
   6. Circuit Setters: Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, CircuitSolver, Tour & Anderson, or equal.

E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems for valves on insulated lines. For manual valves 2-1/2" and larger located 8 feet above the floor in mechanical rooms provide chain operator to permit operating the valve from 4'-0" above floor.

G. Valve Features:
   1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
   2. Drain: Comply with MSS SP-45 and provide threaded pipe plugs.
   3. Flanged: Valve flanges complying with ASME B16.1 (cast iron), ASME B16.5 (steel), or ASME B16.24 (bronze).
   4. Threaded: Valve ends complying with ANSI B2.1.
   5. Solder-Joint: Valve ends complying with ASME B16.18.
   6. Flangeless: Valve bodies manufactured to fit between flanges complying with ASME B16.1 (cast iron), ASME B16.5 (steel), or ASME B16.24 (bronze).

2.05 DOMESTIC PLUMBING SERVICE VALVES

A. Ball Valves:
   1. 2" and Smaller: 600 psi, 2-piece, bronze body, soldered ends for copper pipe and threaded ends for iron pipe, chrome plated brass ball, Teflon seat, brass stem, steel handle, full port, low lead compliant. Apollo Lead Free #77CLF Series or equal.

B. Check Valves:
   1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, soldered ends for copper pipe, screwed cap, swing type, Teflon bronze disc, low lead compliant. Apollo Lead Free #163LF Series or equal.

2. 2-1/2" and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings, low lead compliant. Apollo Lead Free #910F Series or equal.
3. Vertical or High Flow: Class 125, cast bronze, high-flow body, TFE seat, brass check, low lea compliant, stainless steel guide and spring. Apollo Lead Free #61LF Series or equal.

C. Angle Stop Valves:
1. Heavy duty 1/4 turn commercial stop, brass body, chrome plated, 125 psi working pressure, ASME A112.18.1, low lead compliant. Provide with loose key handle in public access spaces for vandal resistance. Chicago Faucets #ST Series, Brasscraft #KT Series, or equal.

D. Slow Closing/Quick Opening Solenoid Valve (2-Way/2-Position):
1. 1/2” to 2-1/2”: Class 125, brass body, stainless steel core, snubber slows disc closing to protect system against water hammer, minimum operating pressure differential 5 psi, 120 VAC input, normally closed (closed when deenergized). Lead-free construction and UL/NSF compliant. Valve shall full stroke close in 4 to 10 seconds and open immediately when energized. Manufacturers: Asco Redhat #8221 or equal.

E. Butterfly valves will not be allowed.

2.06 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure Dependent Water Flow:
1. 1/2" and Larger: Construction and attachment style as required by piping system. Ball or globe valve design with memory stop. Valves shall be field adjustable. Install in pipe with minimum length of unrestricted straight pipe equivalent to five pipe diameters upstream and two pipe diameters downstream. Presso #Venturi B-Plus series, Armstrong, Tour & Anderson, or equal.

2.07 BACKFLOW PREVENTION VALVES

A. General: All backflow prevention valves shall be State approved and listed.

B. Reduced Pressure Principal Backflow Prevention Assembly for High Hazard Applications:
1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall be lead free and include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C511. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Apollo #RP4ALF Series valve with #AGD4A air gap fitting, Watts #LF009 Series with #909 air gap fitting, or equal.

2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall be lead free and include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C511. Stainless Steel body construction, flanged ends, center stem guided check valves, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Apollo Lead Free #RP4ALF-OS&Y valve with #AGD4A air gap fitting, Watts #LF9090 Series with #909 air gap fitting, or equal.

C. Double Check Valve for Low Hazard Applications:
1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C510. Bronze construction, threaded ends, and stainless steel internal parts. Apollo Lead Free #DC4ALF Series or equal.
2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, and stainless steel internal parts. Apollo Lead Free #DC4ALF Series or equal.

D. Atmospheric Vacuum Breaker: Assembly shall consist of a bronze vacuum breaker body with silicone disc, and full size orifice. Device shall be IAPMO listed, lead free and comply with ASSE 1011. Chrome plated in finished occupied areas. Apollo #HB Series or equal.

E. Pressure Vacuum Breaker: Assembly shall consist of a bronze or stainless steel body, with stainless steel spring loaded check, lead free, atmospheric vent and ASSE 102 compliant. Chrome plated in finished occupied areas. Apollo #PVB Series or equal.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers: Assembly shall consist of a non-metallic body, Acetal or equal, or stainless steel for corrosion resistance. Assembly shall include replaceable/repairable check valves, strainer, atmospheric vent, and ASSE 1022 and ANSI/NSF-61 compliant. Apollo #CBBP Series or equal.

2.08 PRESSURE REDUCING VALVES

A. Pressure Reducing Valves (PRV) - Up to 2-1/2”
1. Lead free single seated, direct operated type; high capacity, having bronze body, serviceable in line, sealed spring cage, reinforced Buna-N diaphragm, by-pass feature, pressure gauge tapings, inline strainer and complying with requirements of ASSE Standard 1003.
2. Manufacturer: Watts #LF 223 Series, Apollo Lead Free #36HLF Series, Cash Acme, or equal. Refer to schedule on drawings as applicable.

B. Automatic Pressure Reducing Valves (ACV) - 1-1/2" and larger
   1. Lead-free pilot operated diaphragm valve type designed to automatically reduce a fluctuating higher upstream pressure to a constant lower downstream pressure. The valve shall contain a disc and diaphragm assembly that forms a sealed chamber below the valve cover, separating operating pressure from line pressure.
   2. The main valve body shall be ASTM A536 ductile iron. Internal cast components shall be ductile iron or 316 stainless steel. All ductile iron components shall be lined and coated with NSF 61 certified epoxy coating applied by electrostatic heat fusion. All main valve trim and throttling components shall be stainless steel. The diaphragm shall be constructed of nylon reinforced Buna-N.
   3. Pilot control system for valves 3" and smaller shall contain a flow clean strainer, fixed orifice closing speed, adjustable opening speed control and pressure reducing pilot. Pilot control systems for valves 4" and larger shall contain an external Y-strainer, fixed orifice closing speed, pressure reducing pilot and isolation ball valves on all body connections. All pilot control systems shall utilize copper tubing and brass fittings. The adjustment range of the pressure reducing pilot shall be 30-300 psi.
   4. Manufacturer: Watts #LFM115 Series, Apollo Lead Free #36HLF Series, Cash Acme, or equal. Refer to schedule on drawings as applicable.

2.09 PRESSURE RELIEF VALVES

A. Pressure Relief Valve: Lead free bronze body construction, thermostat and test lever, and initial pressure relief set at 125 psi (adjust for system requirements). Certified to meet ASME low pressure heating boiler code.

B. Manufacturers: Watts #LF3L, Cash Acme #LFF-95 Series or equal.

2.10 TEMPERATURE AND PRESSURE RELIEF VALVES

A. Temperature and Pressure Relief Valve: Lead free bronze body construction, thermostat and test lever, temperature relief set at 210ºF, and pressure relief set at 125 psi. Certified to meet ASME low pressure heating boiler code and ANSI Z21.22.

B. Manufacturers: Watts #LF Series (100XL, 40, 140, N240, 340), Cash Acme #FVX Series or equal.
   1. Vacuum Relief Valves
      a. Vacuum Relief Valve: Lead free brass body construction, protective cap, 1/2" male NPT, maximum operating temperature 250^0F. Tested and rated to ANSI Z21.22.
      b. Manufacturers: Watts #LFN36 Series, Cash Acme #VR-801, or equal.

2.11 THERMOSTATIC MIXING VALVE – LAVATORIES AND BATHTUBS

A. Mixing valve shall be ASSE 1070 (Performance Requirements for Water Temperature Limiting Devices) compliant with adjustable and lockable means to limit the hot water temperature setting for individual fixtures such as lavatories and bathtubs. Where fixtures have integral ASSE 1070 compliant valves there is no additional requirement for upstream temperature limitation control. Provide valve for individual fixtures or combined flows up to 6 gpm.

B. Refer to drawings for locations, capacities, pressure drops, flow rates, and models.

C. Thermostatic valve constructed of brass, bronze or stainless steel body, with screwdriver locking temperature regulators, check stops, removable/replaceable cartridge, stainless steel piston, brass pipe fittings, and unions. Interior parts in standard rough bronze, nickel or chrome finish. Valve shall be lead-free. Include cold water bypass fitting where required by faucet.

D. Provide chrome or nickel plated body where installed exposed under a lavatory. Provide stainless steel cabinet with wall mounting bracket for valve when installed inside the concealed cabinet.

E. Manufacturers: Chicago Faucet #131 Series, Symmons #Maxline 7 Series, Apollo #34 Series, Leonard #LF Series, Cash Acme #HG Series, Caleffi #5213, Nibco/Webstone #H-77200 Series or equal.

2.12 THERMOSTATIC MASTER MIXING VALVE ASSEMBLY – HIGH/LOW FLOW

A. Master mixing valve assembly shall be ASSE 1017 certified and meet low lead requirements of wetted surface area containing less than 0.25% lead by weight. Compliant with ASME A112.18.1/CSA B125.1. For master flow rates serving multiple fixtures with a demand greater than 6 gpm.

B. Factory assembled cabinet with two thermostatic mixing valves to serve broad range of flow conditions and adjustable to leaving water temperature of 105-140°F. Refer to drawings for locations, capacities, pressure drops, flow rates, and models.

C. Full cabinet enclosure for all components. Stainless steel or powder coated steel cabinet for recessed or surface mounting with hinged access door. Refer to drawings for mounting requirements. Top or bottom water supplies as required. Provide access door with cylinder lock. Finish color as selected by Architect or Owner’s Representative.

D. Thermostatic valve constructed of brass and stainless steel, with screwdriver locking temperature regulators, pressure reducing valve, check stops, removable/replaceable cartridge, stainless steel piston, ball valves, two pressure gauges, bimetal dial thermometer (20°F to 200°F range), brass pipe fittings, and unions. Interior parts in standard rough bronze, nickel or chrome finish.

E. Manufacturers: Leonard #TM Series or equal.

2.13 WATER METERS

A. Water meter shall have a mechanical drive with hermetically sealed registers; meter shall be equal to or exceed AWWA Standards and shall have an all bronze case. Meter shall also include “dual-output” capability using a programmable frequency pulse output compatible with BAS (Building Automation System) integration. Coordinate BAS integration requirements with BAS Controls Installer for monitoring and trend logging of water use (gallons). Provide water meter with shutoff valves on each side of meter. Provide flanges on valves and support stands or wall brackets for meter support. Meter shall be approved for use by local water district.

B. Manufacturers: Hersey Products, Niagara, Rockwell, Mueller, Neptune, Sensus or equal.

2.14 BACKWATER VALVE

A. Provide backwater sewer valve in gravity discharge piping to protect the ground floor, and lower levels of the sanitary sewer system, where any floor levels are below the next upstream street manhole cover.

B. Fixtures installed on a floor level that is lower than the next upstream manhole cover of the public or private sewer shall be protected from backflow of sewage by installing an approved type of backwater valve. Fixtures on such floor level that are not below the next upstream manhole cover shall not be required to be protected by a backwater valve. Fixtures on floor levels above such elevation shall not discharge through the backwater valve. Cleanouts for drains that pass through a backwater valve shall be clearly identified with a permanent label stating “backwater valve downstream”.

C. Cast iron body with backwater valve, bolted cover, and wheel handle to provide complete closure. Valve design shall permit access to backwater valve assembly, for servicing or cleaning, through a "full opening" bolted cover or threaded cover. Provide full-size, cast iron, soil pipe extension to field-installed cleanout at floor level. Provide 30” diameter fiberglass or cast iron basin with accessible cover appropriate for finished floor surface or grade level.

D. Manufacturer: JR Smith #7050 Series, Zurn #Z1088, or equal.

2.15 THERMOMETERS AND GAUGES

A. General:
   1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
   2. No mercury shall be used in thermometers due to hazardous material classification.
   3. Manufacturers: Weksler, Winters, Trerice, Marshalltown or US Gauge.

B. Thermometers:
   1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
      a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3" diameter dial, with adjustable angle.
      b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
      c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
      d. Stem: Stainless steel, adjustable angle socket, length to suit installation.
   2. Glass Thermometer: Provide adjustable angle 9” thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
      a. Case: Aluminum or reinforced plastic.
      b. Temperature Sensitive Gage Liquid: Organic non-toxic. No mercury permitted.
      c. Scale: Aluminum painted white with black markings.
      d. Connection: 1/2” NPT with thermowell or 1-1/4” UNF swivel nut without thermowell.
   3. Photovoltaic Cell Powered LCD Thermometer
      a. Case: ABS Plastic
      b. Accuracy: 1% of full scale.
      c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celsius.
      d. Connection: 3/4” NPT with thermowell or 1-1/4” UNF swivel nut without thermowell.
   4. Conform to the following temperature ranges:
      a. Hot Water: 20°F - 240°F with 2°F scale divisions.
      b. Cold Water: -40°F - 160°F with 2°F scale divisions.

C. Thermometer Test Wells:
   1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature Gauge Connector Plugs:
   1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Construct of brass and finish in nickel-plate, equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" OD probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:
1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
4. Connector: Brass with 1/4" male NPT.
5. Scale: White coated aluminum, with permanently etched markings.
6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.

F. Pressure Gauge Cocks:
1. General: Provide pressure gauge cocks/valves between pressure gauges and gauge tees on piping systems. Two-piece bronze body ball valve with threaded ends. Manufacturers: Milwaukee #BA-100 or equal.
2. Snubber: 1/4" brass or stainless steel bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating. Manufacturers: Wika #910.12, Ashcroft #1112, or equal.

G. Pressure Gauge Connector Test Plugs:
1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Constructed of lead-free brass, with 1/4” or 1/2" NPT fitting, with self-sealing valve core type neoprene or Buna-N gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.16 PIPING SPECIALTIES

A. General:
1. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Pipe Escutcheons:
1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.

2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Air Vent with Valves:
1. Cold water and hot water vent valve with 1/4 turn ball shut-off valve. Tapped at top for 1/8” or 1/4” NPT drain connection. Removable top and built-in check valve. Maximum operating pressure 75 psi. Maximum operating temperature 250°F.
2. Manufacturers: Hoffman #79, Dole #75 or equal.

D. Unions:
1. Unions shall be of type specified in following schedule:
   a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
   b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
   c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
   d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
   e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
2. Manufacturers: EPCO, Mueller, Stanley G. Flagg, Watts, or equal.

E. Flanges:
1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather.
3. Ratings: 150 lb. or 300 lb. in high pressure portions.
4. Type of pipe and corresponding flanges as follows:
   a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
   b. Welded Steel Pipe, 150 lb. black forges steel welding flanges, 1/16" raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.

F. Dielectric Fittings:
   1. Dielectric Unions:
      a. Provide standard products recommended by manufacturer for use in service indicated to effectively isolate ferrous from non-ferrous piping to prevent galvanic action and related corrosion.
      b. Manufacturers: Watts #LF3000 Series, Zurn #DUX Series, or equal.
   2. Dielectric Waterways/Nipples:
      a. Comply with standard IAPMO PS 66.
      b. Electroplated steel waterway/nipple complying with ASTM F1545 or ASTM F492.
      c. Pressure Rating: 300 psig (2070 kPa) at 225°F (107°C).
      d. End Connections: Male threaded or grooved.
      e. Lining: Inert and noncorrosive, propylene.
      f. Manufacturers: Mifab #MI-DE Series, Victaulic #Series 647, or equal.
   3. Dielectric Flanges:
      a. Comply with standard ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 125 psig (860 kPa) minimum at 180°F (82°C).
      d. End Connections: Solder or brazed joint copper alloy and threaded ferrous; or threaded solder-joint copper alloy and threaded ferrous.
      e. Dielectric-Flange Insulating Kits:
         1) Nonconducting materials for field assembly of companion flanges.
         2) Gasket: Neoprene or phenolic.
         3) Bolt Sleeves: Phenolic or polyethylene.
         4) Washers: Phenolic with steel backing washers.
      f. Manufacturers: Watts #LF3100 Series or equal.

G. Transition Couplings:
   1. Coupling connection for grooved end AWWA ductile iron pipe to grooved end IPS stainless steel pipe, including valves or fittings of the same nominal size. Use grooved dielectric nipple for transition to copper tubing.
      a. Housing: Ductile iron conforming to ASTM A-536, grade 65-45-12 or ductile iron conforming to ASTM A-395, grade 65-45-15.
      b. Coating: Coal tar epoxy coating, 3 mils minimum thickness, for buried piping transition.
      c. Gasket: Grade “M” FlushSeal, halogenated butyl (brown color code). Temperature range –20°F to +200°F (–29°C to 93°C). Specially compounded to conform to ductile pipe surfaces. UL classified in accordance with ANSI/NSF 61 for cold potable water service.
      d. Bolts/Nuts: Heat-treated plated carbon steel or stainless steel 316 for buried applications, compliant with the physical and chemical requirements of ASTM A-449 and physical requirements of ASTM A-183.
      e. Manufacturers: Victaulic #Style 307 or equal.

H. Pipe Sleeves:
1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
2. Sleeves shall provide a minimum 1/2" annular clearance around pipe. Where pipes cross through footings or footing walls provide a minimum 1” annular clearance between sleeve and pipe.
3. Sheet metal: Fabricate from 0.025” (0.64 mm) minimum, sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves to extend a minimum of 1” above finished floor. Manufacturers: Adjust-to-Crete, Crete-Sleeve, Hilti, or equal.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.
9. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.
    a. Outer Sleeves: EPDM attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.
    b. Water Stop Mid-Body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve.
    c. Manufacturers: HoldRite #HydroFlame, or equal.

I. Mechanical Sleeve Seals for Underground Penetrations:
1. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
2. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
3. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.
4. Manufacturers: Metraflex #Metraseal, Advance Products & Systems #Innerlynx, GPT #Link-Seal, or equal.

J. Mechanical Sleeve Seals-Aboveground Penetrations:
   1. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
   2. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.
   3. Wood Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
      a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE, Hydroflame Sleeve, or equal.
      b. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
      c. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
      d. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested according to ASTM E 814 or ANSI/UL 1479.
   4. Steel Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.
      a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/Holdrite; Hydroflame CMD Metal Deck Device, or equal.
      b. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
      c. Includes a cone attached to the base for extending the device through the metal deck and a water stop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
      d. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested per ASTM E 814 or ANSI/UL 1479.
   5. Concrete Description: Cast-in-place, watertight tub box drain block out firestop device for use in floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke and fire, and hot gasses.
      a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/Holdrite, Hydroflame Tub Box, or equal.

b. Consists of a reinforced polymer box containing a 2-1/2-inches (63.5 mm) thick polystyrene foam insert with an upper water seal consisting of absorbent material and a pitched water trough.
c. Include a sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
d. Include two support legs each with a radial extended flange for balance and for fastening to concrete formwork, and a lower water-seal and radial extended flange attached to the lower end of the sleeve for fastening to concrete formwork and a water stop gasket with three concentric raised rings for embedment and sealing to the concrete slab.
e. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested per ASTM E 814 or ANSI/UL 1479.

K. Low Pressure Y-Type Pipeline Strainers:
1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations (233 @ 0.045" perforations per square inch).
2. Threaded ends, 2" and smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with hose bibb. Manufacturers: Sarco, Wheatley, Mueller or equal.
3. Flanged ends, 2-1/2" and larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with hose bibb. Manufacturers: Sarco, Wheatley, Mueller or equal.
4. Grooved ends 2-1/2” and larger: Ductile iron body, bolted screen retainer with off center blowdown fitted with hose bibb. Manufacturers: Victaulic, Gustin-Bacon or equal.

L. Drip Pans:
1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection. Extend 1” drain to nearest approved receptor.

M. Valve Boxes:
1. Concrete body, cast iron cover with vandal resistant screws, extensions as required to extend full depth to valve. Valve box cover lettering shall correspond to the valve service, "Water", "Fire", "Sewer", etc.
2. Manufacturers: Christy #G8 or equal.

2.17 EXPANSION COMPENSATORS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ASME B31.1 for pressure piping. Vertical piping shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Manufacturers: Keflex #311 series or equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Manufacturers: Metraflex #Metraloop or equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Manufacturers: Metraflex #SST or equal.

E. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Manufacturers: Metraflex #BBS or equal.
   1. For non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/Kevlar fabric rated 190#/26" vacuum at 250°F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Manufacturers: Garlock #206 EZ-FLO or equal.
   2. Flexible Ball Pipe Joints: Provide flexible ball pipe joints where indicated for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 360° rotation, and with minimum of 50° angular flexing movement for sizes 1/4" to 4". Provide two composition gaskets for each joint. Barco or approved equal.

F. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Manufacturers: Metraflex #Style IV or equal.

G. Expansion Loops: Provide field fabricated pipe expansion loops as an alternate to mechanical expansion joints.

PART 3 - EXECUTION

3.01 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install water piping and fixtures uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work, unless so indicated on Drawings or approved by Architect or Owner’s Representative.

C. Pipe showing rust or cracks in coating shall be removed and replaced.

D. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

E. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Owner’s Representative.

F. The cooperative work not included in the Plumbing Division related to the general construction work is as follows:
1. All formed concrete work.
2. Framed openings in masonry and other Architectural and Structural elements.
3. Wood grounds and nailing strips in masonry and concrete.
4. Sloping of floors to drains and floor sinks.
5. Sloping of roof surfaces to roof drains and overflow drains.

G. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps (waterproof membrane) to protect equipment and piping delivered to and stored at the site.

H. All backflow preventers require adequate access clearance for future testing and maintenance. The backflow prevention device shall be installed with not less than 12 inches of clearance between the lowest portion of the assembly and grade, floor or platform. Installation of backflow prevention devices mounted more than five (5) feet above the floor shall be provided with a permanent platform capable of supporting a tester or maintenance person. The measurement is taken from the centerline of the device to the floor or platform.

I. Install engineered siphonic drain specialties and storm drainage piping in locations indicated.

3.02 PIPES SIZES TO EQUIPMENT

A. General: Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.

B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.03 PIPING INSTALLATION

A. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Where buried domestic cold water routes into a building-on-grade the piping shall not penetrate the slab or perimeter structure and must extend vertically a minimum of 12” above finished floor level before penetrating the exterior perimeter wall.
   1. A blue insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall be not less than 14 AWG and the insulation type shall be suitable for direct burial.

D. Pipes Penetrating Foundation Walls and Grade Beams: Any pipe that passes through a foundation wall or grade beam shall be provided with a relieving arch or a pipe sleeve shall be built into the foundation wall or grade beam. The sleeve shall be constructed of a section of pipe that is two pipe sizes greater than the pipe passing through the structure. Coordinate the location and size of each penetration with the structural engineering design before any work is performed.

E. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Special precautions must be adhered to in such rooms and in the vicinity of such critical equipment. Do not run piping through these electrical equipment spaces and enclosures unless unavoidable. Where, unavoidable, install drip pan, with 2” high sides, under water piping and drainage piping that must be run through electrical spaces. Route 3/4" drip pan drain piping to floor drain, floor sink or other approved receptor. All copper water piping in such rooms must use brazed joints. Soldered or mechanical joints are not allowed at joint in water piping within these locations.

F. Hospital Operating Rooms, Delivery Rooms, Nurseries, Food Preparation Areas, Food Serving Facilities, Food Storage Areas and other Sensitive Areas: Special precautions must be followed to not route any drainage piping above these areas, unless unavoidable. All aboveground no-hub drainage piping shall use four-band type couplings. Install drip pan, with 2” high sides, under drainage piping that must be run through these spaces. Route 3/4” drip pan drain piping to floor drain, floor sink or other approved receptor with readily observable termination.

G. Hospital Operating Rooms, Delivery Rooms, Nurseries, Food Preparation Areas, Food Serving Facilities, Food Storage Areas and other Sensitive Areas: All copper water piping in such rooms must use brazed joints. Soldered or mechanical joints are not allowed in water piping within these areas.

H. Install automatic air vents, with shutoff valves, in all closed specialty plumbing systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each vent valve to facilitate servicing. A 1/4" or 3/8" type "L" copper tubing drain line shall be run to drain receptor to carry away water that valve discharges.

3.04 DOMESTIC HOT WATER PIPE LENGTH TO FIXTURES

A. The maximum allowable piping length for domestic hot water from the nearest source of heated water to the termination of the fixture supply pipe shall comply with requirements of local energy code. For public lavatories and hand washing sinks the maximum piping length shall not exceed three feet (one meter). For other fixtures, such as showers, kitchen sinks, and scrub sinks, the maximum piping length shall not exceed ten feet (three meters). Adjust routing of hot water supply and recirculation piping as required to meet these maximum piping lengths. In addition, for buildings under IECC jurisdiction comply with maximum requirements of Table C404.5.1.

3.05 CONDENSATE DISPOSAL

A. Condensate piping shall be type L or M copper tubing with wrought copper fittings.

B. Primary drain pan shall be provided with cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections.

C. Provide secondary drain pipe for mechanical equipment above ceilings and route to visible location or approved receptor.

D. All air conditioning condensate drain lines from each air handling unit and rooftop unit shall be piped full size of the unit drain outlet, with "P" trap, and piped to nearest drain. See details shown on the drawings or the manufacturer's instructions for depth of air conditioning condensate trap to exceed unit static pressure. Condensate drain lines shall not be less than 3/4" internal diameter and shall not decrease in size from the outlet of the drain pan connection to the place of condensate disposal.

E. Equipment manufacturer shall provide outlet size to align with condensate drain sizing tables in the mechanical and plumbing codes. Unit outlet size shall be 3/4" for equipment capacity to 20 ton of refrigeration and 1" for equipment capacity over 20 tons to 40 tons of refrigeration.

F. Run horizontal indirect waste condensate drainage piping at uniform pitch of not less than 1/8" per foot (1%).

3.06 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Pipes passing through foundation walls or grade beams shall be provided with a relieving arch or a pipe sleeve built into the foundation wall or grade beam. The sleeve shall be a minimum of two (2) pipe sizes larger than the pipe passing through the wall or beam. Coordinate specific sleeve penetration locations with structural design for placement of sleeves.

C. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) minimum annular clear space between piping and concrete slabs and walls.
   1. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed.
   2. Sleeves are not required for core-drilled holes.

D. Install sleeves in concrete floors, concrete roof slabs, and concrete/masonry walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2” (50 mm) minimum above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

E. Install sleeves for pipes passing through fire rated interior partitions as required by assembly construction.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4” (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
   4. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping." Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

3.07 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
   1. Install cast-in-place watertight sleeves for pipes NPS 6” (DN 150) and smaller in diameter.
   2. Position cast-in-place watertight sleeve in wall space securing sleeve to reinforcing steel using tie wire.

D. Underground, Exterior-Wall, Cast-in-Place Watertight Penetrations. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
   1. Install cast-in-place watertight sleeves for pipes NPS 6” (DN 150) and smaller in diameter.
   2. Secure sleeve to the reinforcing steel using tie wire.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples.

3.08 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges/burrs, and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings. Bevel plain ends of steel pipe.

B. Piping shall be capped during construction to prevent entry of foreign material.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Provide joints of type indicated in each piping system and as required to meet the maximum allowable working pressure and maximum testing pressures.

E. Thread pipe in accordance with ANSI/ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly.
   1. Apply appropriate (Teflon) tape or thread compound to external pipe threads. on male threads at each joint and tighten joint to leave not more than three (3) threads exposed.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Soldered and brazed copper water tube and fittings: Comply with maximum allowable rated internal working pressures as defined in ASME B31.9, and matching table in ASHRAE Handbook-HVAC Systems and Equipment, based on maximum service temperature and pipe diameter.

ASME B31.9-2008 Table 917.3 Rated Internal Working Pressure of Joints Made With Copper Water Tube and Solder Joint Fittings (psig)					
Solder or Brazing	Maximum Service Tem-perature (°F)	Types K, L, M Copper Water Tube in Nominal Sizes (inches) Liquids and Gases			
		1/4" to 1”	1-1/4” to 2”	2-1/2” to 4”	Up to 8”
Tin Alloys ASTM B32	100	500	400	300	270
	150	400	350	275	250
	200	300	250	200	180
	250	200	175	150	135
Brazing Al-loys	200	Tube Rating	Tube Rating	Tube Rating	Tube Rating
	250	300	210	170	150
	350	270	190	150	150

G. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32, in accordance with plumbing code requirements, ASTM B828 and Copper Development Association (CDA) recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications and shall meet CDA standard test method 1.0 and ASTM B813. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.

H. Mechanically Formed Extruded Tee Fittings: Form tee in copper tube according to ASTM F2014. Forming procedures shall be in accordance with the tool manufacturer’s recommendations. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar. Formed tee fitting shall not be greater than 50% of the diameter of the main run tube/pipe. Soldered joints are not allowed.
   1. Mechanically formed extruded outlets shall be perpendicular to the axis of the run tube (main pipe). Holes shall be formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the branch wall.
   2. Branch tubes shall not restrict the flow in the run tube. A dimple (depth stop) shall be formed in the branch tube to ensure that penetration into the collar is of the correct depth. For inspection purposes, a second dimple shall be placed 0.25 inch above the first dimple. Dimples shall be aligned with the tube run.
   3. Manufacturer: T-Drill or equal.

I. Braze copper tube and fitting socket or mechanically formed tee fittings with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

1. Brazing fittings may use a mechanically limited depth that is not less than the minimum cup depth (overlap) specified by ANSI/ASME B16.50 for Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings. Manufacturer of mechanical dimpler: Brazing Dimpler Corp or equal.

J. Depth of solder joint and braze joint fitting:

Depth of Solder Joint and Braze Joint Fittings		
Pipe Size (inches)	ASME 16.22 Solder Joint Socket Depth (inches)	ASME B16.50 Brazed Joint Socket Depth (inches)
1/2	0.50	0.22
3/4	0.62	0.25
1	0.75	0.28
1-1/4	0.97	0.31
1-1/2	1.09	0.34
2	1.34	0.40
2-1/2	1.47	0.47
3	1.66	0.53
4	2.16	0.64
5	2.66	0.73
6	3.09	0.83
8	4.09	1.28

K. Alternative domestic water piping mechanical press type connections with pre-approval from Owner’s Representative. Copper press fittings shall be made in accordance with the manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer. Copper press fittings shall conform to the material and sizing requirements of ASME B16.22. O-rings for copper press fittings shall be EPDM.

L. Cast-Iron Sanitary Sewer Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

M. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

N. Joint Construction for Grooved-End, Ductile-Iron Water Piping to Copper Tubing: For transition site piping to building copper piping make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

O. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9. Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

P. Weld pipe joints in accordance with recommendations of American Welding Society AWS D1.1 and ASME Boiler and Pressure Vessel Code Section IX.
1. Weld pipe joints only when ambient temperature is above 0°F.
2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
3. Use pipe clamps or tack-weld joints with 1" long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" and larger.
4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
5. Do not weld out piping system imperfections by tack-welding procedures. Refabricate to comply with requirements.
6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.

3.09 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping Outside of Building Footprint:
1. Fittings for NPS 1-1/2” (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2” (DN 50) and Larger: Sleeve-type coupling or grooved type fitting.

C. Transition Fittings in Aboveground Domestic Water Piping: Unions, flanges, grooved fittings, or connect to isolation valve to meet field conditions and maintain pressure testing requirements.

3.10 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing such as copper to zinc plated equipment fittings. Dielectric couplings shall not be used as unions in a copper to copper piping systems with connections to brass or stainless steel valves/devices.
   1. Dielectric Fittings for NPS 2” (DN 50)] and Smaller: Use dielectric couplings, nipples, unions.
   2. Dielectric Fittings for NPS 2-1/2” to NPS 4” (DN 65 to DN 100): Use dielectric flange kits or threaded nipples.
   3. Dielectric Fittings for NPS 5” (DN 125) and Larger: Use dielectric flange kits.

3.11 VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves to be accessible. Provided separate support as necessary.
   2. Install manual shutoff valves to isolate cold and hot water services to each restroom group. Back-to-back or adjacent men’s and women’s restrooms are considered a group. Shutoff valves shall be located immediately above or adjacent to the restroom(s) for easy maintenance access.
   3. Install valves on all services connected to kitchen equipment.
   4. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   5. All valves mounted higher than 7' above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6' above floor.
   6. For multistory buildings with showers and without domestic cold water pressure booster system: Provide a pressure reducing valve in the cold water service downstream of the cold water branch serving the water heating equipment where the cold water service pressure is greater than 10 psi above the domestic hot water serving the remote shower mixing valves. This will equalize the pressures serving the shower valves to normalize the operation of the valves to assure proper temperature operation. The requirement for a pressure reducing valve cannot be assessed until completion of piping, valves, mixing valves and water heating installation.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
   1. Copper Pipe, 2-1/2" and Smaller: Soldered-joint valves.
   2. Steel Pipe, 2" and Smaller: Threaded joint valves.
   3. Larger Pipe Sizes: One of the following, at installer's option:
      a. Flanged valves.
      b. Lug valves.

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, ball, plug, circuit setter, and globe valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

J. Backwater Valve: Provide backwater sewer valve in gravity discharge piping to protect the ground floor, and lower levels of the sanitary sewer system, where any floor levels are below the next upstream street manhole cover, not invert limited. Fixtures, including grease traps, installed on a floor level that is lower than the next upstream manhole cover of the public or private sewer shall be protected from backflow of sewage by installing an approved type of backwater valve. Fixtures on such floor level that are not below the next upstream manhole cover shall not be required to be protected by a backwater valve. Fixtures on floor levels above such elevation shall not discharge through the backwater valve. Cleanouts for drains that pass through a backwater valve shall be clearly identified with a permanent label as “backwater valve downstream”.

K. Valve Identification: Tag each valve in accordance with Section 220500.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

3.12 TEMPERATURE GAUGES AND THERMOMETERS

A. General: Install temperature gauges/thermometers in vertical upright position and tilted to be easily read by observer standing on floor without supplemental illumination.

B. Install in the following locations and elsewhere as indicated:
1. At outlet of hot water heaters/boilers over 100,000 Btuh (30 kW) input.

3.13 MECHANICAL SLEEVE SEALS

A. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

B. Fire Barrier Penetration Seals: Fill entire opening with sealing compound in compliance approved and listed UL system number. Adhere to manufacturer's installation instructions.

3.14 SUPPORTS AND HANGERS (SEE 220500-BASIC PLUMBING MATERIALS AND METHODS)

3.15 VIBRATION CONTROL ISOLATORS

A. Refer to Section 220548 – Vibration Isolation for Plumbing Piping and Equipment.

3.16 EQUIPMENT RAILS AND PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.17 EXPANSION COMPENSATION

A. Expansion Loops/Connectors at Expansion Joints:
1. Provide flexible hose expansion loop(s) or connectors as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction, building settlement, or seismic movement of the piping system.
2. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal house, compatible braid, 180 deg return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
3. Flexible loops shall be capable of movement in the ±X, ±Y, and ±Z planes to meet or exceed the limits identified in the structural design.
4. Flexible hose expansion loops and connectors shall impart no thrust loads to system support, anchors or building structure.

5. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.
6. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.

B. Expansion Compensation for Risers and Terminals:
1. Install connection between horizontal piping mains and vertical piping risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

C. Thermal Expansion Compensation:
1. Provide piping U-Bend, Z-Bend, L-Bend or flexible devices to accommodate thermal expansion and contraction in piping system where shown on drawings and as required to impart minimal stress in water piping and building structure.

3.18 CATHODIC PROTECTION OF METAL PIPE

A. Cathodic Protection: Provide cathodic protection for buried exposed steel or copper piping. Assume that 25 percent of the exterior of the steel casing is exposed metal. Cathodic protection systems shall have a minimum design life of 25 years and shall be designed in accordance with recommendations of NACE SP-01-69 Control of External Corrosion on Underground or Submerged Metallic Piping Systems (latest edition). Provide all anodes, wiring, dielectric pipe flange kits, and any additional required isolation devices, at points necessary within vaults or at building terminations. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure. Coordinate with Section 264200 Cathodic Protection. (Note to Editor: Coordinate directly with electrical designer to provide Section 264200 Cathodic Protection for buried steel piping or remove form scope.)

3.19 EXCAVATION AND BACKFILL

A. Underground piping shall be installed in stable, open trench work. Trench excavations shall be a minimum of 16” wide, true to line and grade. Contractor shall exercise all due shoring and safety procedures. No stones larger than 1” may be present in the trench to a minimum depth of 4” below the trench bottom. The trench shall be free of job site debris, and free of corrosive media.

B. Pipe crown, outside the building footprint, shall be not less than 24” below the finished ground surface for metallic pipe, and 30” for non-metallic pipe, unless otherwise indicated on the Civil drawings or directed by the Owner’s Representative. Trenches shall be kept free of excess moisture and shall be kept open for only a short a time as necessary for installation, testing and inspection. Dispose of surplus excavation and seepage water as directed by the Owner’s Representative. Comply with minimum depths as defined in local plumbing code for building sewer piping outside the building footprint.

C. Piping shall be properly bedded and backfilled over stable trench bottom to a level of at least 12” above the pipe crown where located outside the building footprint, and not less than 2” above pipe crown where pipes are located within the building footprint. Use thin layers of unwashed sand, dampened but not puddle, and free of organic or corrosive materials and excessive moisture. Backfill shall be placed in thin layers not to exceed 6” and tamped by mechanical tampers to a minimum 90% Modified Proctor Density, in accordance with ASTM D-1557-58T. Alternate backfill material may be Class I or II SE-30+ fill with minimum 30 percent sand and maximum 1/2" diameter particle size.

D. Trenches shall be backfilled to a minimum depth of 36” prior where vehicle loading is required.

E. Replace to their original condition all turf, plants, concrete, asphalt, or other improvements which constitute landscaping, traffic areas or other improved areas which become disturbed by excavation. In graded and undeveloped areas, in addition to procedures specified above, backfill trenches with crown 8” above the surrounding surface.

F. Excavated and backfill in soils of unstable nature shall be provided as directed the Owner’s Representative.

3.20 PIPE INSPECTIONS

A. Inspections shall be performed at each phase while under tests required for administrative authorities, and prior to concealment, i.e. “rough-in”, “top-out” and “final”.

B. Inspection – Underground: All piping installed underground shall be inspected prior to burial by the Owner’s Representative. Contractor must notify Owner’s Representative no less than 24 working hours prior to inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection – Aboveground: All piping installed Aboveground shall be made available for inspection upon completion and prior to finish of walls and ceilings. Contractor must notify Owner’s Representative no less than 24 working hours prior to the desired inspection time. Should the piping be hidden within the structure prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.21 CLEANING, FLUSHING, DISINFECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

B. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items.

C. Inspect pressure piping in accordance with procedures of ASME B31.

D. Disinfect water mains and water service piping in accordance with Section 220500.

3.22 TESTING

A. Provide all tests specified hereinafter. All tests shall meet or exceed the minimum requirements of applicable codes and local ordinances. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The system may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times the system operating pressure or the listed test pressure below, whichever is greater:

System	Test Medium	Test Pressure	Tolerance-Test Period
Domestic Water	Water	150 psig	None – 8 hours
Sanitary Sewer and Gravity Condensate (non-plastic)	Water	10 ft head (or 5 psi air)	No leaks – 8 hours
Pumped Sanitary and Condensate	Water	150 psig or 150% of pump shutoff head, whichever is greater	None – 8 hours
Vent (non-plastic)	Air	5 psi	No leaks – 8 hours
Vent (non-plastic)	Water	10 ft head	No leaks – 8 hours
Rainwater	Water	10 ft head (or 5 psi air)	No leaks – 8 hours

D. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

E. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, air vents, trap primers, and vacuum breakers for proper performance. Test all air vent points to ensure that all air has been vented.

F. Backflow Preventers: Each testable backflow prevention device shall be tested and approved by certified testers after installation. Submit test results.

END OF SECTION

SECTION 22 34 00 - DOMESTIC HOT WATER HEATING EQUIPMENT

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this section shall include but not necessarily be limited to the following:
   1. Water heaters
      a. Electric, Tankless, Domestic-Water Heaters

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 22 0500: Basic Plumbing Materials and Methods

B. Section 22 4000: Plumbing Fixtures

1.04 QUALITY ASSURANCE – WATER HEATERS

A. Manufacturers and Representatives Qualifications. Firms regularly engaged in manufacture of water heating equipment, systems and service shall have been active in the field and whose products have been in satisfactory use in similar service for not less than five years.

B. Uniform Energy Factor (UEF): Water heater efficiency metric applicable to residential and small commercial water heaters. The higher the UEF value is, the more efficient the water heater. UEF is determined by the Department of Energy's test method in 10 CFR Part 430, Subpart B, Appendix E. UEF rating label must be applied to water heater.

C. First Hour Rating (FHR): An estimate of the maximum volume of hot water in gallons that a storage water heater can supply within an hour that begins with the water heater fully heated. The FHR is measured at a 135°F outlet temperature in the Energy Factor test method and at a 125°F outlet temperature in the Uniform Energy Factor test method.

1.05 SUBMITTALS

A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Water heaters.

B. Electrical Work: Refer to Division 22, Section 22 0500 for requirements and coordinate with Division 26.

C. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.

D. Water Heater Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 gpm to maximum value of water heater.

E. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, elevations, sections, and methods of assembly of components and anchorages.

F. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

G. Operation and Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 01. Submit operational manuals.

H. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.

I. Start-up: Provide written report on start-up in accordance with Section 22 0500.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.

1.07 COORDINATION

A. Coordinate size and location of concrete bases and attachments with structural design. Coordinate with Divisions 03 for specification of concrete, reinforcement and formwork requirements.

1.08 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 22 0500 for additional warranty and Substantial Completion requirements.

C. Tanks shall have a three-year (36 months) warranty against leaks.

PART 2 - PRODUCTS

2.01 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
1. Manufacturer: Chronomite or equal.
2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
4. Connections: ASME B1.20.1 pipe thread.
5. Pressure Rating: 150 psig (1035 kPa).
6. Heating Element: Resistance heating system.
7. Temperature Control: Thermostat.
8. Safety Control: High-temperature-limit cutoff device or system.
9. Jacket: Aluminum or steel with enameled finish or plastic.
10. Support: Bracket for wall mounting.
11. If more than one thermostat-control, electric, tankless, domestic-water heater is required on Project, delete subparagraph below and schedule thermostat-control, electric, tankless, domestic-water heaters on Drawings.
12. Capacity and Characteristics:
13. Refer to Equipment Schedule for additional specification information.

PART 3 - EXECUTION

3.01 GENERAL

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected. Refer to

drawings and other specification sections for locations, dimensions and features required for each piece of equipment.

B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

C. Orient equipment so controls and devices needing service and maintenance have adequate access and code required clearances.

D. Connect piping with shutoff valves and unions as required for maintenance and system isolation.

E. Connect all drain outlets and route to approved termination locations as shown on the drawings and as required by code.

F. Start-Up: Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls. Start-up to be by authorized manufacturer's representative or agent.

3.02 WATER HEATER EXAMINATION

A. Before water heater installation, examine roughing-in for equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting water heater performance, maintenance and operations.
   1. Final water heater locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where equipment heaters will be installed. Coordinate with Owner’s Representative if there are concerns about proposed equipment locations. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 WATER HEATER INSTALLATION

A. Install water heaters in accordance with local, state, provincial, and national codes, laws, regulations, and ordinances.

B. Comply with manufacturer’s installation instructions, including required service clearances.

C. Install electrical devices furnished with water heater but not specified to be factory mounted.

D. Install control wiring to field-mounted electrical devices.

3.04 WATER HEATER CONNECTIONS

A. Piping installation requirements are specified in other Division 22 sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to water heater to permit service and maintenance.

C. Connect cold and hot water piping to inlet and outlet connections with shutoff valves.

D. Ground equipment according to Division 26 Section - Grounding and Bonding for Electrical Systems.

E. Connect wiring according to Division 26 Section - Low-Voltage Electrical Power Conductors and Cables.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections
   1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper unit operation.
   4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.06 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES

A. General: Refer to Section 22 0500 for requirements.

END OF SECTION

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 22 0500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the installation of plumbing fixtures and trim.

1.03 RELATED WORK IN OTHER SECTIONS

A. Section 22 0500: Basic Plumbing Materials and Methods

B. Section 22 3000: Plumbing Equipment

1.04 SUBMITTALS

A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
1. Plumbing fixtures.
2. Piping specialties.
3. Toilets.
4. Urinals.
5. Lavatories.
6. Sinks.
7. Showers,
8. Drinking fountains.

B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with Architectural Woodwork shop drawings specified in Division 06 for fixtures installed in countertops and cabinets. Furnish templates for use in woodwork shop.

C. Samples: Submit samples of any piece of equipment requested by Architect for review and approval.

D. Wiring Diagrams: Submit manufacturer's electrical requirements and wiring diagrams for power supply to units. Clearly differentiate between portions of wiring that are factory installed and field installed portions.

1.05 CODES AND STANDARDS

A. Applicable Plumbing Code with State Amendments.

B. All fixtures and accessories must be approved for use by the State and local jurisdictions.

C. All fixtures and faucets must meet all requirements of Americans with Disabilities Act (ADA).

D. California Building Code (CBC) 2022 11B

E. State Energy Code

F. ARI Standard 1010: “Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.”

G. NSF 372: Materials containing not more than 0.2 percent lead when used with respect to solder and flux and not more than a weighted average of 0.25 percent when used with respect to the wetted surfaces of pipes and pipe fittings, plumbing fittings, and fixtures, providing a specified definition and formula for determining “weighted average”.

1.06 QUALITY ASSURANCE

A. Battery Operation: For those plumbing fixtures provided with battery operated valves (toilets, urinals, and sink faucets) powered by lithium or alkaline batteries shall be selected with a minimum operational service life of six (6) years based on 4000 operations per month. Any failure of batteries during the first six years of service, from the date of Certificate of Occupancy, shall be replaced by the installing contractor at no additional charge to the Owner.

B. High Efficiency Toilet (HET) Performance: High efficiency (HET) toilets (water closets) shall have a Maximum Performance (MaP) score rating of 800 grams, or greater, as listed by the Alliance for Water Efficiency (http://www.allianceforwaterefficiency.org). Sanitary sewer pipes serving HET fixtures shall be sloped at a minimum of 2% for pipe sizes up to 4” diameter.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products. Remove damaged products from project site.

1.08 MAINTENANCE

A. Extra Stock:
1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures, flush valves, and trim to Owner's Representative with receipt in a quantity of one device for each 10 fixtures.
2. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, o-rings, sleeves, and seats in a quantity of one kit for each 10 faucets.

1.09 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 22 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide fixtures as specified. Fixtures in any secure or public areas shall be vandal proofed.

B. Architect/Engineer shall review and approve any substitution requested by Contractor prior to bid submittal.

C. Provide fixture as specified, Refer to plumbing drawings.

D. Provide faucet as specified. Refer to plumbing drawings.

E. Distributed Stream, Pressure Compensating, Low Flow Faucet Device:
1. Provide pressure compensating flow control or laminar flow control devices on public access faucets for office buildings, hotels, motels, schools, restaurants and other public facilities. Refer to plumbing fixture schedule on Drawings for flow rates.
2. Pressure compensation flow control device shall be capable of delivering specified flow rate over the supply pressure range of 40-80 psi. Each device shall incorporate a self-cleaning feature. Accuracy shall be +/- 10% of the flow rate specified.

3. Housing shall be constructed of brass and nickel-chrome plated. Perforated plates shall be brass, stainless steel or acetal. Screens shall be series 300 stainless steel or acetal. Entire assembly shall be lead free. Provide vandal resistant feature.
4. Manufacturer: Neoperl #PCA Mikado Tre Spray 0.35 gpm, Omni (Chronomite) #A Series, or equal.

F. Provide thermostatic mixing valves and fixtures conforming to ASSE 1070, ASSE 1069 and ASSE 1016. Limit the maximum water temperature to 110°F for all public lavatories and 120°F for all other public fixtures served with hot water. Handle position stops and temperature mixing valves shall be used as required to limit maximum temperature to prevent scalding. Water heater thermostats shall not be considered a suitable control.

G. Provide flush valve as specified. Refer to plumbing drawings.

H. Provide commercial grade toilet seat as specified. Refer to plumbing drawings.

I. Provide heavy-duty cast iron commercial grade carrier as specified. Provide compact carriers where space is limited. Comply with ASME A112.6.1M for Floor-Affixed Supports for Off-The-Floor Plumbing Fixtures for Public Use. Provide cast iron nipples and couplings with neoprene gaskets, or better. Plastic nipples and couplings are not allowed. Manufacturers: Jay R. Smith, Watts, Josam, Wade, Zurn, Mifab, or equal.
1. Wall hung water closet with optional flush valve support where applicable: J.R. Smith Fig #0210 Series, #0240 Series, #0410 Series, or equal.
2. High performance wall hung water closet carrier for HET compliant fixtures: Zurn #Z1201/Z1202, or equal.
3. Wall hung urinal: J.R. Smith Fig #0634-M12, Zurn #Z-1221-58, or equal.
4. Wall hung lavatory with concealed arm carrier: J.R. Smith Fig #0700–M31, or equal.

J. Provide heavy duty commercial grade 17-gauge P-Trap and supplies with stops as specified. Provide heavy duty commercial grade lavatory supplies. Provide supplies meeting AB1953 no lead requirements. Supplies shall be 1/2"x 3/8" x 12" ground joint flexible riser with loose key angle stop with chrome plates IPS brass nipple. Sink supplies shall be ½" x 12" ground joint flexible riser with loose-key angle stop with chrome plated IPS brass nipple. Provide bell type escutcheons for both P-trap and supplies. Manufacturers: Zurn, Brasscraft, Chicago, McGuire, or equal.
1. P-Trap for lavatory: McGuire #C8902-DF, Zurn #Z-8701, or equal.
2. P-Trap for sink: McGuire #C8912-DF, Zurn #Z-8702, or equal.
3. Supply for lavatory: McGuire #LFH2165LK, Zurn #ZH88-XL-LK, or equal.
4. Offset supply for barrier free lavatory: McGuire #158 WC, or equal.
5. Supply for sink: McGuire #LFH2167LK, Zurn #ZH8803-XL-LR, or equal.
6. Supply for water closet: McGuire #H2169LK, Zurn #ZH-8807-CR, or equal.
7. Escutcheons: McGuire #WE00D Series, wrought brass, bell type, or equal.
8. Lavatory grid strainer: McGuire #155A, Zurn #Z-8743, or equal.

9. Barrier-free lavatory offset grid strainer: McGuire #155WC, Zurn #8746, or equal.
10. Sink strainer: Elkay LK-18B, or equal.

K. ADA Undersink Wrap: Provide white molded closed cell vinyl pre-fab insulation on P-Trap and on both hot and cold water supply for barrier free lavatories and sinks. Bag type insulators are not acceptable. Manufacturers: Plumberex, Truebro, Zurn, or equal.

2.02 WATER CLOSETS

A. Water Closets WC-1: Wall mounted, top spud.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Kohler Co.
   c. TOTO USA, INC.
2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: Standard.
   f. Rim Contour: Elongated.
   g. Water Consumption: 1.28 gal. per flush.
   h. Spud Size and Location: NPS 1-1/2; top.
3. Flushometer Valve: WCFV-1.
4. Toilet Seat: WCTS-1.
5. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
   c. Water-Closet Mounting Height: Standard.

B. Water Closets WC-2: Wall mounted, top spud, accessible.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Kohler Co.
   c. TOTO USA, INC.
2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.

e. Height: ADA.
f. Rim Contour: Elongated.
g. Water Consumption: 1.28 gal. per flush.
h. Spud Size and Location: NPS 1-1/2; top.

3. Flushometer Valve: WCFV-1.
4. Toilet Seat: WCTS-1.
5. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
   c. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.03 FLUSHOMETER VALVES

A. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves WCFV-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan Valve Company.
   b. TOTO USA, INC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: 1.1 gal. per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.:

2.04 TOILET SEATS

A. Toilet Seats WCTS-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bemis Manufacturing Company.
   b. Church Seats; Bemis Manufacturing Company.

c. TOTO USA, Inc.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

2.05 WALL-HUNG URINALS

A. Urinals UR-1: Wall hung, back outlet, washout:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard.
b. Kohler Co.
c. TOTO USA, Inc.
2. Fixture:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Washout with extended shields.
d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
e. Water Consumption: Ultra High Efficiency.
f. Spud Size and Location: NPS 3/4, top.
g. Outlet Size and Location: NPS 2, back.
h. Color: White
3. Flushometer Valve: URFV-1.
4. Waste Fitting:
a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.
5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.06 URINAL FLUSHOMETER VALVES

A. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves URFV-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Sloan Valve Company.
b. TOTO USA, Inc.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.

6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
11. Consumption: 0.125 gal. per flush.
12. Minimum Inlet: NPS 3/4.
13. Minimum Outlet: NPS 3/4.

2.07 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

A. Lavatory L-1 Oval, vitreous china, undercounter mounted:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Kohler Co.
   c. TOTO USA, Inc.
2. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1.
   b. Type: For undercounter mounting.
   c. Nominal Size: Oval, 17 by 14 inches.
   d. Faucet-Hole Punching: No holes.
   e. Faucet-Hole Location: On countertop.
   f. Color: White.
   g. Mounting Material: Sealant and undercounter mounting kit.
3. Faucet: LF-1.

B. Lavatory L-2: Vitreous china, wall mounted, with back:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Kohler Co.
   c. TOTO USA, Inc.
2. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1.
   b. Type: For wall hanging.
   c. Nominal Size: Oval, 20 by 18 inches.
   d. Faucet-Hole Punching: One hole.
   e. Faucet-Hole Location: Top.
   f. Color: White.
   g. Mounting Material: Chair carrier.
3. Faucet: LF-1.

4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.

2.08 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets LF-1: Automatic-type, hard-wired, electronic-sensor-operated, mixing, solid-brass valve:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Kohler Co.
   c. TOTO USA, Inc.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.35 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator.
12. Drain: Not part of faucet.

2.09 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material: Chrome-plated, one-piece, cast-brass trap with swivel 0.029-inch- thick

2.10 SERVICE BASINS

A. Service Basins SS-1: Terrazzo, floor mounted:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard.
      b. Fiat Products.
      c. Zurn.
   2. Fixture:
      a. Standard: IAPMO PS 99.
      b. Shape: Radial front.
      c. Nominal Size: 24 by 24 inches.
      d. Height: 12 inches with dropped front.
      e. Tiling Flange: On two sides.
      f. Rim Guard: On front top surfaces.
      g. Color: Not applicable.
      h. Drain: Grid with NPS 3 outlet.
   3. Mounting: On floor and flush to wall.
   4. Faucet: SSF-1.

2.11 UTILITY BASINS

A. Utility Sinks S-1: Stainless steel, single bowl undermount sink:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Moen
      b. American Standard.
      c. Elkay Manufacturing Co.
      d. Zurn.
   2. Fixture:
      a. Standard: ASME A112.19.3/CSA B45.4.
      b. Type: Ledge back.
      c. Number of Compartments: One.
      d. Overall Dimensions: 23-1/8” X 17-7/8”
      e. Metal Thickness: 0.050 inch.
   3. Compartment:
      a. Dimensions: 21" x 15"-3/4”
      b. Drain: Grid with NPS 2 tailpiece and twist drain.
   4. Color: Not applicable.
      a. Drain: Grid with NPS 3 outlet.
   5. Faucet(s): SF-1.
      a. Number Required: One.
      b. Mounting: On ledge.
   6. Supply Fittings:
      a. Standard: ASME A112.18.1/CSA B125.1.

b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
   1) Operation: Loose key.
   2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

7. Waste Fittings:
   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):
      1) Size: NPS 1-1/2.
      2) Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
8. Mounting: On counter with sealant.

B. Utility Sinks S-2: Stainless steel, counter mounted:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kohler
   b. American Standard.
   c. Elkay Manufacturing Co.
   d. Zurn.
2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4.
   b. Type: Ledge back.
   c. Number of Compartments: One.
   d. Overall Dimensions: 30”x20”x8-5/16”.
   e. Metal Thickness: 0.050 inch.
   f. Compartment:
      1) Dimensions: 15” X 15”.
      2) Drain: Grid with NPS 2 tailpiece and twist drain.
   g. Color: Not applicable.
   h. Drain: Grid with NPS 3 outlet.
3. Faucet(s): SF-1.
   a. Number Required: One.
   b. Mounting: On ledge.
4. Supply Fittings:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
      1) Operation: Loose key.
      2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
5. Waste Fittings:
   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):
      1) Size: NPS 1-1/2.

2) Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.

6. Mounting: On counter with sealant.

2.12 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets SF-1: Pull-down kitchen sink faucet with three-function sprayhead.
1. Commercial, Sollid-Brass Faucets.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Kohler
2) American Standard.
3) Elkay Manufacturing Co.
4) Zurn.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Chrome plated.
7. Maximum Flow Rate: 1.5 gpm.
8. Mounting Type: Deck, concealed.
9. Spout Type: Rigid, solid brass.
10. Vacuum Breaker: Not required.
11. Spout Outlet: Aerator.

C. Sink Faucets SF-2: One-Handle Lavatory Faucet
1. Commercial, Sollid-Brass Faucets.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Moen
2) American Standard.
3) Elkay Manufacturing Co.
4) Zurn.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.

6. Finish: Chrome plated.
7. Maximum Flow Rate: 1.2 gpm.
8. Mounting Type: Deck, concealed.
9. Spout Type: Rigid, solid brass.
10. Vacuum Breaker: Not required.
11. Spout Outlet: Aerator.

2.13 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:
1. NPS 1/2
2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.14 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/2.
2. Material: Chrome-plated, one-piece, cast-brass trap with swivel 0.029-inch- thick tubular brass wall bend; and chrome-plated brass or steel wall flange

2.15 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.16 DRINKING FOUNTAIN

A. Drinking Fountains EWC-1: Stainless steel, wall mounted, Bottle Filling Station & Versatile Bi-Level ADA Cooler

B. Non-Filtered Non-Refrigerated Light Gray
1. Stainless-Steel Drinking Fountains
   a. Elkay Manufacturing Co.
   b. Grainger Industrial Supply
2. Standards:
   a. Comply with ASME A112.19.3/CSA B45.4.
   b. Comply with NSF 61 Annex G.
   c. Type Receptor: With back.
3. Receptor Shape: Rectangular.
4. Back Panel: Stainless-steel wall plate behind drinking fountain.
5. Bubblers: One with adjustable stream regulator, located on deck.
6. Control: Push bar.
7. Drain: Grid type with NPS 1-1/4 tailpiece.
8. Supply: NPS 3/8 with shutoff valve
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
10. Support: ASME A112.6.1M, Type III lavatory carrier.

C. Drinking Fountains EWC-2: Stainless steel, wall mounted, Vandal-Resistant Bottle Filling Station & Single Cooler Non-Filtered Non-Refrigerated Stainless
1. Stainless-Steel Drinking Fountains
   a. Elkay Manufacturing Co.
   b. Grainger Industrial Supply
2. Standards:
   a. Comply with ASME A112.19.3/CSA B45.4.
   b. Comply with NSF 61 Annex G.
   c. Type Receptor: With back.
3. Receptor Shape: Rectangular.
4. Back Panel: Stainless-steel wall plate behind drinking fountain.
5. Bubblers: One with adjustable stream regulator, located on deck.
6. Control: Push bar.
7. Drain: Grid type with NPS 1-1/4 tailpiece.
8. Supply: NPS 3/8 with shutoff valve
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
10. Support: ASME A112.6.1M, Type III lavatory carrier.

K. Install P-Trap tight to outlets from lavatories and shower drains to minimize the vertical water drop and related drainage noise. Outlet drops longer than 7” to P-trap water level are not acceptable.

L. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

M. Inspect each installed unit for damage. Replace damaged fixtures.

N. During construction cover all installed fixtures, sinks, and water coolers with cardboard boxes and wrap with water proof plastic sheeting.

O. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream.

P. Replace washers or cartridges of leaking or dripping faucets and stops.

Q. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.02 INSTALLATION

A. Water-Closet Installation:
1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to CBC 11B-604.4 (17” – 19” AFF measured to the top of the seat)

B. Urinal Installation:
1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to CBC 11B-605.2. (17” max. AFF measured to the top of the front rim)

C. Support Installation for Water-Closet:
1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.

PART 3 - EXECUTION

3.01 GENERAL

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.

D. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

E. Comply with the installation requirements of ADA with respect to plumbing fixtures for the physically handicapped.

F. Floor mounted carrier support systems for wall mounted water closets, urinals, and lavatories:
   1. Shall be attached to 3” or thicker concrete slab floors using four 1/2" diameter concrete wedge anchor expansion bolts with minimum 2” embedment and minimum 1-1/2” spacing between anchors at each support location as provided by manufactured carrier. Each bolt shall be capable of withstanding a tension pull-out force of 2,000 lbs. minimum in cracked concrete. Refer to additional manufacturer installation requirements. Manufacturer: Hilti #Kwik Bolt TZ or equal.
   2. Shall be attached thru elevated floors using four 1/2" diameter through bolts at each support location as provided by manufactured carrier. Each bolt shall be capable of withstanding a tension pull-out force of 2,000 lbs. minimum in cracked concrete. Refer to additional manufacturer installation requirements.

G. Fasten plumbing fixtures securely to supports behind wall or building structure. Secure supplies behind or within wall construction to provide rigid installation.

H. Install a stop valve in an accessible location in the water connection to each fixture.

I. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

J. Seal fixtures to walls and floors using sealants as specified in Division 07. Match sealant color to fixture color.

4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

D. Support Installation for Urinal:
1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

E. Flushometer-Valve Installation:
1. Install flushometer-valve, water-supply fitting on each supply to each water closet and urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
5. Install actuators in locations that are easy for people with disabilities to reach.
6. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

F. Install toilet seats on water closets.

G. Wall Flange and Escutcheon Installation:
1. Install locations and within cabinets and millwork.
2. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
3. Install deep-pattern escutcheons if required to conceal protruding fittings.
4. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping.".

H. Joint Sealing for Water-Closet:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

I. Joint Sealing for Urinal:
1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

J. Lavatory Installation:
1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.

3. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to CBC 11B-605.2.
4. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
5. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
6. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

K. Sink Installation:
1. Install sinks level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-hung sinks.
3. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
4. Set floor-mounted sinks in leveling bed of cement grout.
5. Install water-supply piping with stop on each supply to each sink faucet.
   a. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
   b. Install stops in locations where they can be easily reached for operation.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
7. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation.".

L. Drinking Fountain Installation:
1. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
2. Install recessed drinking fountains secured to wood blocking in wall construction.
3. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

4. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
5. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
7. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants.

3.03 CONNECTIONS

A. Connect fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping.".

D. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

3.04 ADJUSTING

A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves/faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

A. After completing installation of the fixtures, inspect and repair damaged finishes.

B. Clean the fixtures and fittings with manufacturers' recommended cleaning methods and materials.

C. Install protective covering for installed fixtures and fittings.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 05 00 - BASIC HVAC MATERIALS AND METHODS

PART 1 GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.02 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Pipe Portals
   16. Pipe Supports
   17. Equipment Rails
   18. Access Doors
   19. Identification Markers
   20. Coordination of Electrical requirements for equipment provided

1.03 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete heating, ventilating, air conditioning systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate this work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipelines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

E. The contractor shall design and supply all miscellaneous metals and system support components that are necessary to support all mechanical system, whether indicated or not on the drawings. Such metals and support components and related connections shall be provided as necessary to directly and concentrically impost loads on the primary structure. Refer to structural design requirements for specific attachment requirements. The mechanical system supports shall accommodate lateral movements between floors as defined in the story drift requirements.

F. The contractor shall design and supply mechanical devices and system components that are necessary to accommodate structural movement as defined by structural design criteria associated with ductwork and piping transitions through building expansion joints. Design of expansion joints to allow for dimensional changes in portions of a structure separated by such joints should take both reversible and irreversible movements into account.

1.04 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
   2. Before proceeding with work check and verify all dimensions.
   3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
   4. Make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
   5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
   6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Owner’s Representative interpretation and decision as early as possible, including during bidding period.

1.05 DEFINITIONS

A. Above Grade: Not buried in the ground and not embedded in concrete slab on ground.

B. Accessible: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

C. Actuating or Control Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

D. Below Grade: Buried in the ground or embedded in concrete slab on ground.

E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

F. Connect: Complete hook-up of item with required service.

G. Drift: The horizontal deflection at the top of the story relative to the bottom of the story. Refer to structural design for drift dimensional movements.

H. Expansion Joint: A mid-structure separation designed to relieve stress on building materials caused by building movement induced by any of the following: thermal expansion and contraction; wind sway; seismic events; static load deflection; or live load deflection. Expansion joint systems are used to bridge the gap and maintain building assembly functions while accommodating expected movements. Expansion joints also include transitions from an existing building to a new building addition. Refer to structural design for expansion joint dimensional movements.

I. Explosion Proof Equipment (per National Electrical Code-Article 501): Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. Explosion proof motors are required for Class I, II or II applications regardless of Division or Group as defined in National Electrical Code – Article 501 and ANSI/ISA-12.20.01.
    1. Class I: Hazardous due to flammable gases or vapors are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
    2. Class II: Hazardous due to combustible or conductive dusts are present or may be present in quantities sufficient to produce explosive or ignitable mixture.
    3. Class III: Hazardous dues to ignitable fibers are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
    4. Division: The substance referred to by Class has a high probability (Division 1) or low probability (Division 2) of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.
    5. Group: Type of hazardous material in surrounding environment ranging from Group A flammable liquids to Group G combustible dusts.

J. Exposed: Not installed underground or concealed.

K. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when

tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.

L. Furnish: To supply equipment and products as specified.

M. Indicated, Shown or Noted: As indicated, shown or noted on Drawings or Specifications.

N. Install: To erect, mount and connect complete with related accessories.

O. Motor Controllers: Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.

P. Must: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall.

Q. Noncombustible Material: A noncombustible material is a substance that will not ignite, burn, support combustion, or release flammable vapors when subject to fire or heat in compliance with ASTM E136 Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C. Examples of noncombustible materials include the following, but confirm compliance in manufacturer literature:
   1. Portland cement concrete, concrete, gypsum concrete (normally used in drywall or poured gypsum floor toppings), Portland cement stucco, Portland cement plaster, and gypsum plaster, gypsum wall board (sheetrock), and Type X gypsum wall board.
   2. Brick masonry, concrete block masonry, and ceramic tiles.
   3. Steel, stainless steel, galvanized steel, and other metals, except aluminum (aluminum is classified as limited-combustible), magnesium and magnesium alloys.
   4. Sheet glass, block glass, and uncoated glass fibers.
   5. Mineral wool and rock wool.

R. NRTL: Nationally Recognized Testing Laboratory, including UL and/or ETL.

S. Piping: Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

T. Provide: To supply, install and connect as specified for a complete, safe and operationally ready system.

U. Reviewed, Satisfactory or Directed: As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner’s Representative.

V. Rough-In: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

W. Shall: An exhortation or command to complete the specified task including providing and installing work associated with task.

X. Similar or Equal: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Y. Supply: To purchase, procure, acquire and deliver complete with related accessories.

Z. Typical or Typ: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

AA. Will: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall".

BB. Wiring: Raceway, fittings, wire, boxes and related items.

CC. Work: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 23 Mechanical sections included herein.

B. Division 33: Utility Site Work.
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work required for mechanical work shall be coordinated by Division 23 with Division 03 including:
   2. Concrete curbs and housekeeping pads for the mechanical equipment.
   3. Thrust blocks, pads, and boxes for mechanical equipment.

D. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal.
   2. Sealants and caulking.
   3. Firestopping.

E. Division 09: Painting.
   1. Division 23 shall coordinate with Division 09 to perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials
   3. Paint all exposed gas piping, interior and exterior to the building, yellow.

F. Division 10: Miscellaneous Metals.
   1. Exterior louvers and grilles shall be included in this Section.

G. Division 26: Electrical.
   1. Power connections to all mechanical equipment

H. Division 28: Electronic Safety and Security.
   1. Fire protection alarms and relays.
   2. Smoke detector and monitoring.
   3. Life safety systems.

1.07 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All accessible mechanical work shall comply with the minimum requirements of the Americans with Disabilities Act (ADA) and local amendments. Also, refer to ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities. Refer to Architectural drawings and specifications for additional ADA requirements. The following requirements are provided as consolidated list of minimum ADA requirements. Compliance requirements applicable to HVAC work includes, but is not limited to, the following:
   1. Section 309: Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds maximum.
   2. Section 308.3: Temperature control devices mounted on walls with operable buttons or switches shall be placed where clear floor or ground space allows a parallel approach and the side reach is unobstructed. Operable parts shall be located 48” maximum above finished floor, and no lower than 42” above finished floor. Do not mount above light switches to avoid inaccurate temperature readings due to light switch heat output.
   3. Section 308.3.2: Where a clear floor or ground space allows a parallel approach to an element and high reach is over an obstruction, the height of the obstruction shall be 34” maximum and depth of obstruction shall be 24” maximum.
   4. Section 404.2.9: Fire doors shall have a minimum opening force allowable by the applicable Building Code. The force for pushing or pulling open a door other than fire doors shall be 5 pounds maximum.

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:

G. California Building Codes enforced by the Authority Having Jurisdiction (AHJ):
   1. 2022 Building Standards Administrative Code, Part 1, Title 24 California Code of Regulations (CCR).
   2. 2022 California Building Code (CBC), Part 2, Title 24 CCR (2021 International Building Code with California Amendments).
   3. 2022 California Electrical Code (CEC), Part 3, Title 24 CCR (2020 National Electrical Code with California Amendments).
   4. 2022 California Mechanical Code (CMC) Part 4, Title 24 CCR (2021 Uniform Mechanical Code with California Amendments).
   5. 2022 California Plumbing Code (CPC), Part 5, Title 24 CCR (2021 Uniform Plumbing Code with California Amendments).

6. 2022 California Energy Code (CEC), Part 6, Title 24 CCR.
7. 2022 California Fire Code, Part 9, Title 24 CCR (2021 International Fire Code with California Amendments).
8. 2022 California Green Building Standards Code (CALGreen), Part 11, Title 24 CCR.
9. 2022 California Referenced Standards, Part 12, Title 24 CCR.
10. Title 19 CCR Public Safety, State Fire Marshal Regulations.
11. Local, city, county and state codes and ordinances.
12. Local Bureau of Buildings.
13. Local Health Department.
14. Local and State Fire Prevention Districts.
15. State Administrative Codes.

H. Provide in accordance with appropriate referenced standards of the following and as referenced in other specification sections:
1. AABC - Associated Air Balance Council
2. ADA - Americans with Disabilities Act
3. ADC - Air Diffuser Council
4. AHRI - Air Conditioning, Heating and Refrigeration Institute
5. AMCA - Air Moving and Conditioning Association
6. ANSI - American National Standards Institute
7. ASCE 7-10 – American Society of Civil Engineers – Minimum Design Loads for Buildings and Other Structures
8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
9. ASME - American Society of Mechanical Engineers
10. ASTM - American Society for Testing Materials
11. AWS - American Welding Society
12. CSA - Canadian Standards Association
13. ETL - Electrical Testing Laboratories
14. FM - Factory Mutual
15. IBC - International Building Code
16. ICC AC156 Seismic Certification by Shake-Table Testing of Nonstructural Components.
17. MSS - Manufacturer's Standardization Society
18. NEMA - National Electrical Manufacturer's Association
19. NFPA - National Fire Protection Association
20. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
21. UL - Underwriter's Laboratories

I. Provide compliance in accordance with the following referenced standard which applies to general system compliance in contrast to specific equipment standards referenced elsewhere:
1. UL-2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces. This is applicable to spaces above suspended ceilings and below raised floors.

1.08 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting

requirements that are different, but apparently equal, to the Owner's Representative for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Owner's Representative for a decision before proceeding.

1.09 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be metallic riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data suitable for the ambient exposure.

B. All work shall include the following:
   1. Manufactured items and equipment shall be a current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

D. Each product and/or equipment type shall be provided by one manufacturer. Mixtures of manufacturers for each product and/or equipment type are not acceptable. Example – all fire dampers shall be supplied by one manufacturer.

E. Special Inspections: Provide structural design and Special Inspections as required in Chapter 17 of the local building code and the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. All anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.

F. Welding Standards:
   1. Welding Qualifications:
      a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The welder must maintain their certification to show qualified welding experience every six months. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.
   2. Welding Procedures:
      a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.
      b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure

Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."

3. Pressure Piping Standards
   a. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.
   b. Comply with ASME B31.9 Building Services Piping standard for the following services:
      1) Conveying fluid between 0°F (-18°C) to 250°F (121°C).
      2) Fluid pressure less than 350 psig.
   c. Comply with ASME B31.1 Power Piping standard for the following services:
      1) Steam.
   d. Comply with ASME B31.3 Process Piping standard for the following services:
      1) Conveying fluid above 250°F (121°C).
      2) Toxic or flammable fluids.

1.10 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permit, licenses, fees and inspections, including, but not limited to, building permits, planning permits, air quality management district permits, operating licenses, utility district fees, special district fees, environmental impact reports, and additional local permits and fees.

D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 23 3113 Air Distribution for a summary of requirements.

E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access. Joints and fittings shall not be located in inaccessible locations such wall, floor and roof penetrations.

F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications for rough-in requirements.

G. Coordinate mechanical equipment and materials installation with other building components.

H. Ductwork and piping dimensions, as identified on drawings and in specifications, refer to the interior free dimensions. Adjust work as necessary to account for larger outside dimensions to account for material wall thickness. Upsize plastic pipe diameters as necessary to maintain minimum interior dimensions.

I. Verify all dimensions by field measurements.

J. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

K. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

L. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

M. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor shall provide for all cutting and patching required for installation of this work unless otherwise noted.

N. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

O. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

P. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

Q. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

R. Coordinate with Owner’s Representative in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

S. All materials (such as supports, gaskets, sealants, insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall be noncombustible or have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Coordinate with all disciplines to assure that all discrete electrical, plumbing and mechanical products located in plenums are non-combustible and compliant with UL 2043.

T. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

U. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced

and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.11 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting their work. It is the specific intention of this section that the contractor's scope of work shall include:

C. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications

D. Minor deviations from the mechanical plans required by architectural and structural coordination.

E. The Contractor shall study the operational requirements of each system, and shall arrange work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the “Electrical Work”. Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

F. Minor deviations to avoid conflict shall be permitted where the design intent is not altered.

G. Advise the Owner’s Representative, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner’s Representative of conflict.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Owner’s Representative for approval.

C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.

D. Delegated-Design Submittal: For structural pipe and equipment supports, vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic, and where required wind forces required to select vibration isolators, seismic and wind restrains, support framing members, and for deigning vibration isolation bases.
   2. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.

E. Submittals and Shop Drawings:
   1. Submit electronic copies of manufacturer's submittal sheets in one (1) coordinated package per Division. Multiple submissions will not be accepted without prior approval of the Owner's Representative. Organize submittal sheets in sequential order aligned with matching specification section numbers.
   2. Provide electronic copies of shop drawings prepared to show details of the proposed installation. Copies of contract design drawings submitted to demonstrate shop drawing compliance will not be accepted.
   3. Paper submittals will only be acceptable if specifically required by Division 01.
   4. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

1.13 COORDINATION DOCUMENTS/SHOP DRAWINGS

A. The Contractor shall prepare coordinated Shop Drawings using the same electronic format as the contract documents.
   1. The shop drawings shall serve to record the coordination of the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances.
   2. The Drawings shall include all mechanical rooms and floor plans.
   3. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Owner's Representative and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor and Owner's Representative.
   4. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination

should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The coordination work shall be prepared as follows:
   1. Two dimensional AutoCAD / Revit based documents:
      a. Contractor shall prepare AutoCAD/Revit coordination drawings to an accurate scale of 1/4" = 1'-0" or larger. Drawings are to be same size as Contract Drawings and shall indicate locations, sizes and elevations above finished floor, of all systems. Lettering shall be minimum 1/8" high.
      b. Contractor shall obtain AutoCAD/Revit drawings from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the HVAC work.
      c. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
      d. Drawings shall incorporate all addenda items and change orders.
      e. Distribute drawings to all other trades and provide additional coordination as needed to assure adequate space for piping, equipment and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.
   2. Three dimensional Revit / BIM based documents (if required for project):
      a. Provide three dimensional Revit model and BIM input information locating all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
      b. Contractor shall obtain Revit model and BIM input from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the fire protection work.
      c. Model shall indicate locations of all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
      d. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
      e. Model shall incorporate all addenda items and change orders.
      f. Distribute Revit model and BIM input information to all other trades and provide additional coordination as needed to assure adequate space for equipment and piping and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.

C. Advise the Owner’s Representative in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner’s Representative of conflict.

D. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owner’s Representative of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

F. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.14 REQUESTS FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 01).
   1. Coordinate and submit each RFI in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
   2. Each RFI shall address single questions and related issues only.
   3. Each RFI shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to the Owner’s Design Representative.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
   1. Project name.
   2. Project number.
   3. Date.
   4. Name of Contractor.
   5. Name of Architect and/or Construction Manager.
   6. RFI number, numbered sequentially and unique.
   7. RFI subject.
   8. Specification Section number and title and related paragraphs, as appropriate.
   9. Drawing number and detail references, as appropriate.
   10. Field dimensions and conditions, as appropriate.
   11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   12. Contractor's signature.
   13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
      a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response to each RFI, plus additional time for Architect and General Contractor to review and forward. Each RFI received by Engineer after 1:00 p.m. will be considered as received the following business day.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Incomplete RFIs or inaccurately prepared RFIs.
      b. RFIs submitted without indication of review and approval for submission by General Contractor or Construction Manager.
      c. RFIs addressing multiple unrelated issues.
      d. Requests for approval of submittals.
      e. Requests for approval of substitutions.
      f. Requests for approval of Contractor's means and methods.
      g. Requests for information already indicated in the Contract Documents.
      h. Requests for adjustments in the Contract Time or the Contract Sum.

i. Requests for interpretation of Engineer's actions on submittals.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

1.15 RECORD DOCUMENTS

A. Maintain set of Coordination Documents (drawings and specifications) marked “Record Set” at the job site at all times and use it for no other purpose but to record on it all the changes and revisions during construction.

B. Record Drawings shall indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.).

C. Record Specifications shall indicate approved substitutions; Change Orders; and actual equipment and materials provided.

D. Provide copy of Record Documents to Testing and Balancing Contractor and Commissioning Agent for use when performing their work.

E. At the completion of the construction transfer all “Record Set” notations to a clean set of drawings and specifications in a neat and orderly fashion that incorporates all site markups to clearly show all changes and revisions to the Contract Documents. Submit copies of Record Documents and CD/DVD disks labeled with all drawings and specifications and other supporting documentation.

F. Refer also to Division 01 for full scope of requirements.

1.16 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of air conditioning units, temperature controls, chillers, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

D. Refer to other Division 23 Sections for additional requirements.

1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Owner’s Representative complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23. Training is to be appropriate to the complexity of the equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

1.18 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping and equipment showing signs of rust shall be removed from site and replaced with new.

1.19 UNIT PRICING SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to Owner’s Representative for preliminary approval a complete list of manufacturer’s names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
   1. Indicate substituted items.
   2. Identify test and balancing agency.
   3. Identify independent testing laboratory for water analysis.

C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.

D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.20 TEMPORARY FACILITIES

A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary heating, air conditioning, ventilation, water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

B. Temporary Heating for Commissioning Tests:
   1. Provide temporary heating where needed to provide false load for commissioning tests.
   2. Temporary heating may be from the permanent heating system of the project or from a dedicated temporary heating system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon what work in place or being installed.

C. Temporary Cooling for Commissioning Tests:
   1. Provide temporary cooling where needed to provide false load for commissioning tests.
   2. Temporary cooling may be from the permanent cooling system of the project or from a dedicated temporary cooling system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon the work in place or being installed.

1.21 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.22 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner’s Representative, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction

of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner's Representative, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.23 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Owner's Representative.

1.24 WARRANTIES

A. Refer to general terms and conditions, as well as warranties and obligations defined in Division 1 of the specifications that provide basic warranty requirements for the entire project.

B. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.

C. All equipment and systems shall be provided with a minimum one-year warranty, or longer, as defined in each subsequent specification section. Warranty shall include all parts, material, labor and travel.

D. Warranty Start Date: The start date for all warranty periods shall be defined as starting from the date of Substantial Completion which shall include the Certificate of Occupancy from the Authority Having Jurisdiction.

E. Refer to individual Specification sections for additional extended warranty requirements.

F. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

G. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

H. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.25 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year, minimum, after Substantial Completion, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in this work.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

2.02 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
   1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
   2. ASCE 7 (Latest Edition): American Society of Civil Engineers-Minimum Design Loads for Buildings and Other Structures.
   3. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
   4. SMACNA: Seismic Restraint Manual: Guidelines for Mechanical Systems.
   5. NFPA: Pamphlet number 13 and 14 for fire protection systems.
   6. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
   7. Manufacturer: Mason Industries, Hilti Inc., B-Line/Tolco (Eaton), Anvil, Erico, Kin-Line, Simpson Strong-Tie Co. Inc., Superstrut, Empire, PHD Manufacturing, Carpenter & Paterson, Powers Fasteners or equal.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS SP-58 types listed.
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
   3. U-Bolts: MSS Type 24.
   4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
      a. Plate: Unguided type.
      b. Plate: Guided type.
      c. Plate: Hold-down clamp type.

5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Upper Attachment Side Beam Bracket: MSS Type 34
9. Upper Attachment Side Beam Angle Bracket: MSS Type 34, UL listed and FM Approved.
10. Single Pipe Roller with Malleable Sockets: MSS Type 41. Rollers are not required for hydronic piping where spring hangers are utilized.
11. Adjustable Roller Hangers: MSS Type 43. Rollers are not required for hydronic piping where spring hangers are utilized.
12. Pipe Roll Stands: MSS Type 44.
13. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

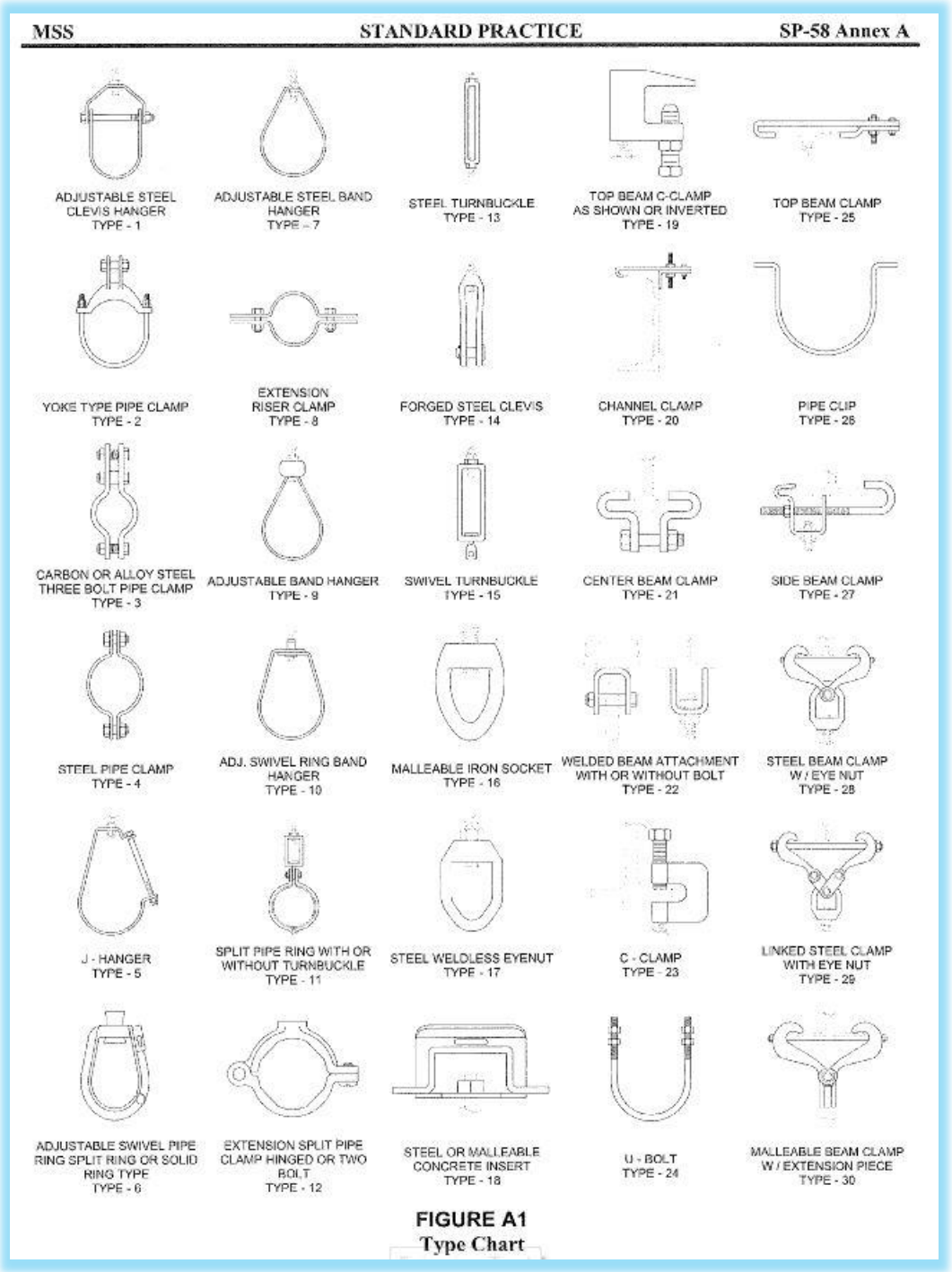


FIGURE A1
Type Chart

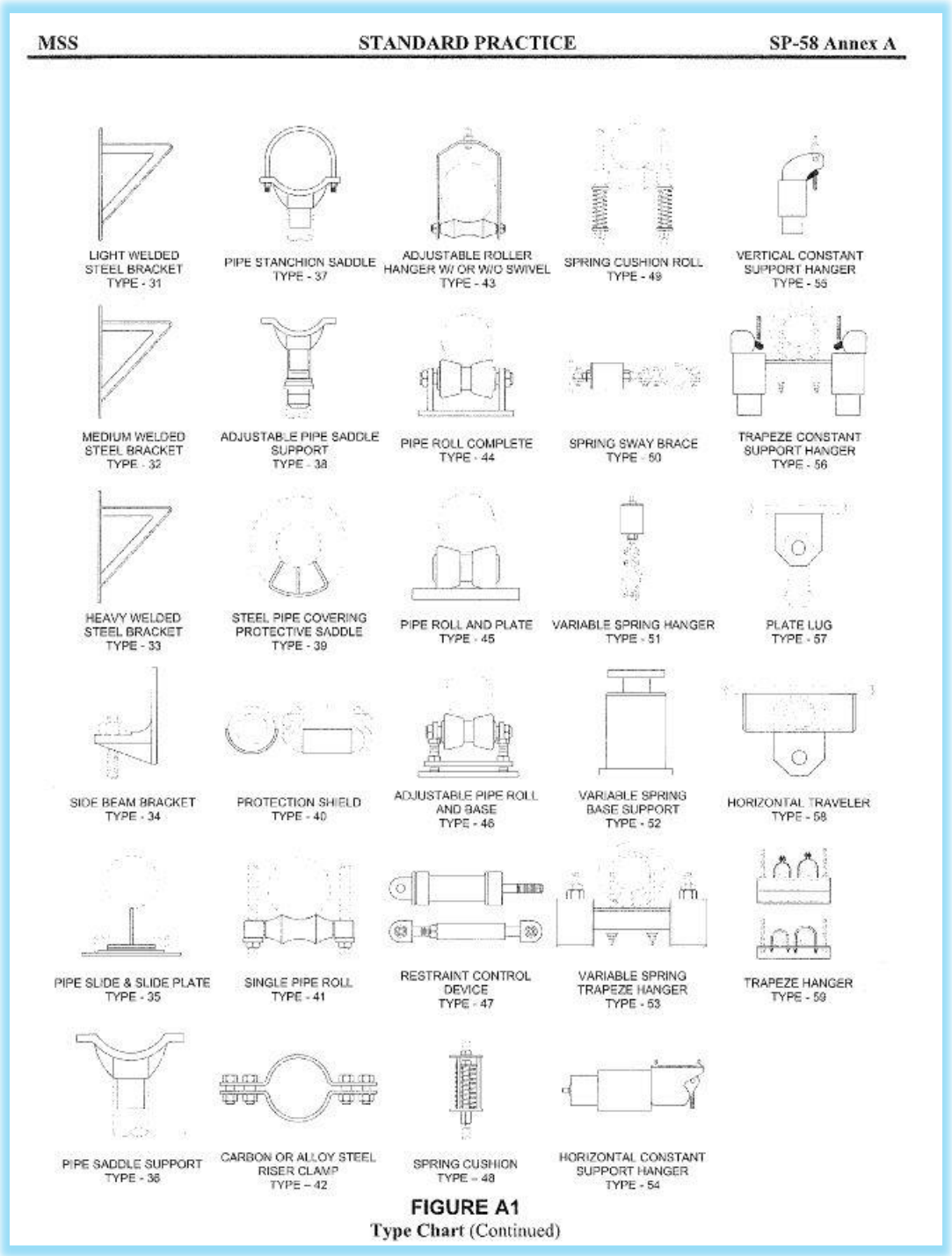


FIGURE A1
Type Chart (Continued)

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp type by many manufacturers.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8 and or four-bolt riser clamps for heavy loads, MSS Type 42. Provide with

1” thick (minimum) neoprene pad on floor with 1/4" thick steel plate to distribute riser clamp weight to pad.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevises: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   4. Malleable Iron Eye Sockets: MSS Type 16.
   5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated by the Structural Engineering design, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts:
      a. MSS Type 18.
      b. Manufacturers: Hilti #KCS-MD (for metal deck) or HCI-WF (for wood forms), Simpson Strong Tie #Blue Banger Hanger, Powers Fasteners #Bang-It (for metal deck) or #Wood-Knocker (for wood forms), or equal.
   2. Steel Brackets: One of the following for indicated loading:
      a. Light Duty: MSS Type 31.
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Concrete Screw Anchors: For floor mounted attachments with maximum allowable pullout and shear force of 250 lbs. (1.1 kN) per anchor regardless of size.
      a. Manufacturers: Hilti #Kwik Hus EZ-I, Simpson Strong-Tie #Titen HD (or Rod Hanger version), Powers Fasteners #Wedge-Bolt+ (Screw Anchor), Powers Fasteners #Vertigo+ (Rod Hanger), Powers Fasteners #Snake+ (Internally Threaded Screw Anchor), or equal.
   5. Torque-Controlled Expansion Anchor:
      a. Manufacturers: Hilti #Kwik Bolt TZ, Simpson Strong Tie #Strong-Bolt 2, Powers Fasteners #Power-Stud+ SD1 or Power-Stud+ SD2, or equal.
   6. Screws and Bolts:
      a. Manufacturers: Bolt Depot, Fastenal, National Bolt & Nut, or equal.
   7. Eye Bolts:
      a. Manufacturers: Lawson Products, Sierra Pacific, US Cargo Control, or equal.
   8. Powder-Driven Concrete Anchors:
      a. Only for existing concrete structures with minimum 4000 psi concrete compressive strength.
      b. Minimum embedment of 1” (25 mm).
      c. Maximum allowable load of 50 lbs (0.2 kN) per anchor.
      d. Manufacturer: Hilti #X or D Series, Powers Fasteners #CSI Series, or equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping at hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with adjacent pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
   a. Pre-manufactured insulated pipe shields are an acceptable alternate where installed per manufacturer's instructions for pipe sizes to 6" diameter. Manufacturers: SnappItz, Armacell #ArmaFix Ecolight or equal.
4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain un-insulated tubing at clevis hangers and strut-mounted clamps.
   a. Manufacturers: Hydra-Zorb #Klo-Shure Insulation Couplings or equal.

H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of one-part cement to three-parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
5. Pipe Brackets: Copper plated brackets and supports for various mounting options. Insulate brackets attached to metal studs with felt.
   a. Manufacturers: Holdrite or equal.

2.03 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
2. Insulation to be 1-1/2" thick, 3 lb. density rigid fiberglass.
3. Curb to have a raised 3" (minimum), 45° cant.
4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
5. Curb height to be 8" (minimum) above roof deck.
6. Cant strips shall be raised to match roof insulation thickness.
7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.

C. Manufacturer: Roof Products Systems, Pate, or equal.

2.04 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping. Coordinate all pipe stands with structural design. Select stands for rated support weight and spacing. Refer to details on drawings for permanent fixed roof support and curbs.

B. Compact Pipe Stand:
   1. Adjustable strut-based support stands shall only be used as intermediate support points between permanent fixed stands/supports as required to prevent pipe from sagging.
   2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   3. Base: Single piece, vulcanized rubber, molded polypropylene or polycarbonate.
   4. Hardware: Galvanized or stainless steel.
   5. Pipe Stand Manufacturers: Dura-Blok, Roof Top Blox, Roof Products Systems, nVent CADDY Pyramid, Portable Pipe Hangers, or equal.
   6. Accessories: Mount on protective roof pad with a minimum of 6” material extending beyond all edges to allow for future pipe movement. Nonwoven pad shall be constructed spaghetti-like strands of flexible plastic with UV inhibitor and rated for -40°F to 180°F (-40°C to +82°C). Manufacturer: Yellow Spaghetti or equal.

C. Single-Pipe Stand:
   1. Adjustable strut-based support stands shall only be used as intermediate support points between permanent fixed stands/supports as required to prevent pipe from sagging.
   2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
   3. Base: Single piece, vulcanized rubber, molded polypropylene, or polycarbonate.
   4. Vertical Members: Two, galvanized or stainless steel, continuous-thread 1/2-inch (12-mm) rods.
   5. Horizontal Member: Adjustable horizontal, galvanized or stainless-steel pipe support channels.
   6. Pipe Supports: Roller, strut clamps, clevis hanger or swivel hanger.
   7. Hardware: Galvanized or stainless steel.
   8. Pipe Stand Manufacturers: Dura-Blok, Roof Products Systems, nVent CADDY Pyramid, Portable Pipe Hangers, or equal.
   9. Accessories: Mount on protective roof pad with a minimum of 6” material extending beyond all edges to allow for future pipe movement. Nonwoven pad shall be constructed of spaghetti-like strands of flexible plastic with UV inhibitor and rated for -40°F to 180°F (-40°C to +82°C). Manufacturer: Yellow Spaghetti or equal.

D. Multiple-Pipe Stand:
   1. Adjustable strut-based support stands shall only be used as intermediate support points between permanent fixed stands/supports as required to prevent pipe from sagging.

2.06 ACCESS DOORS FOR WALL AND CEILING APPLICATIONS

A. Provide all access doors and panels to service equipment under this work, including those which must be installed, in finished architectural surfaces. Refer to other specification sections for specific access doors associated with ductwork and equipment.

B. Construction:
   1. Frame: 16-gauge steel (minimum).
   2. Door: 16-gauge steel (minimum) or two layers of 20-gauge steel (minimum) for double wall door construction.
   3. Hinge: 1" flange width, continuous piano hinge.
   4. Latching System: screwdriver latch, allen key latch or T-handle latch for non-public access areas. Cylinder key lock for public access areas. Cam latch for access to fire/life safety systems.
   5. Paint: white prime coated.

C. Size:
   1. Access doors shall be of a size to permit access and removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer, concealed valve, fire and combination fire/smoke dampers, volume dampers, and other equipment requiring access. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through.

D. Architectural Coordination:
   1. Refer to Division 01 Architectural specifications and drawings for additional requirements for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels are not shown on Plans.
   2. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to service equipment under this work and in the proper sequence to coordinate with construction schedule and with prior approval of the Owner’s Representative.
   3. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
   4. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Owner’s Representative.

E. Manufacturers: Milcor, Karp, Nystrom, Elmdor/Stoneman, Durodyne, Austin Hardware, or equal.

2.07 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils, hand printed, painted, and felt pen markers are not acceptable.

B. Plastic Pipe Markers:

1. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially or fully cover the circumference of pipe, or insulated pipe, and to attach to pipe without fasteners or adhesive complying with ANSI A13.1. Minimum letter size shall be 1/2” high.
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
5. Nomenclature shall include service type and directional arrow as follows:
   a. Chilled Water Supply and Return: green background with white lettering.
   b. Heating Water Supply and Return: yellow background with black lettering.
   c. Condenser Water Supply and Return: green background with white lettering.
   d. Heat Pump Loop Supply and Return: green background with white lettering.
   e. Refrigerant: yellow background with black lettering.
   f. Exhaust air: blue background with white lettering.
   g. Other piping services: Comply with ANSI and ASME A13.1standards.
   h. Direction of water flow.

C. Plastic Duct Markers:
1. Provide duct labels to indicate the system and direction of flow. Submit a labeling product that is suitable for the surface to be labeled.
   a. Pressure sensitive, 16” long by 2-1/4” high (minimum), 3 mil thick high gloss adhesive backed vinyl, 1-1/2” high letters, and color coded per ducted service.
2. Nomenclature shall include service type and directional arrow as follows:
   a. Supply air (cold service): green background with white lettering.
   b. Supply air (hot service): yellow background with black lettering.
   c. Return air: blue background with white lettering.
   d. Relief air: blue background with white lettering.
   e. Outside air: blue background with white lettering.
   f. Exhaust air: blue background with white lettering.
   g. Other air services: Comply with ANSI and ASME A13.1standards.
   h. Direction of air flow.

D. Valve Tags:
1. Brass Valve Tags: Provide 1-1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.
2. Plastic Laminate Valve Tags (indoors only): Provide 3/32” thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32” hole for fasteners.
3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves and manufactured specifically for that purpose.

2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
3. Base: Two or more, vulcanized rubber, molded polypropylene, or polycarbonate.
4. Vertical Members: Two or more, galvanized or stainless steel, channels.
5. Horizontal Member: Two or more, adjustable height, galvanized or stainless-steel pipe support slotted channels or plates.
6. Pipe Supports: Roller, strut clamps, clevis hanger or swivel hanger.
7. Hardware: Galvanized or stainless steel.
8. Pipe Stand Manufacturers: Dura-Blok, Roof Products Systems, nVent CADDY Pyramid, Portable Pipe Hangers, or equal.
9. Accessories: Mount on protective roof pad with a minimum of 6” material extending beyond all edges to allow for future pipe movement. Nonwoven pad shall be constructed of spaghetti-like strands of flexible plastic with UV inhibitor and rated for -40°F to 180°F (-40°C to +82°C). Manufacturer: Yellow Spaghetti or equal.

E. Curb and Rail-Mounted Type Pipe Stands:
1. Shop- or field-fabricated pipe supports made from structural-steel shapes, channels, continuous-thread rods, with rollers, strut clamps, clevis hangers or swivel hangers for mounting on permanent stationary roof curbs.
2. Coordinate with structural design and mechanical details for attachment through membrane.
3. Manufacturer: Pate, Thybar, ThyCurb, Roof Products Systems, Protech, FastCurbs, or equal.

2.05 EQUIPMENT/PIPING RAILS

A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
2. Provide internal reinforcing supports welded as required to meet application requirements.
3. Equipment rails to have raised 3" (minimum), 45° cant.
4. Equipment rails to have 1-1/2" x 1-1/2" wood nailer (minimum) and counterflashing.
5. Equipment rail height to be 6" (minimum) above roof deck.
6. Cant shall be raised to match roof insulation thickness.

C. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required. Coordinate with structural design and mechanical details for attachment through membrane.

D. Manufacturer: Pate, Thybar, ThyCurb, Roof Products Systems, or equal.

E. Access Panel Markers: Provide 1/16" thick (minimum) engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or device.

F. Plastic Equipment Signs:
   1. Provide 4-1/2” x 6” (minimum) plastic laminate sign, ANSI A.13 color coded with engraved white core lettering. Minimum letter size shall be 1/2” high.
   2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
      a. Tag number
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.
   4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2”x11” bond paper, tabulate each equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

G. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

H. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Kolbi, or Brimar.

2.08 ACOUSTICAL BLANKET INSULATION

A. Application:
   1. Wrap high noise producing equipment and ductwork where occupied room noise levels cannot be obtained by architectural room barrier construction alone.
      a. Wrap variable air volume terminal where located above noise sensitive rooms such as conference rooms, lobbies and offices.
      b. Wrap ductwork where located above noise sensitive rooms such as conference rooms, lobbies and offices.
      c. Wrap fans where located above noise sensitive rooms such as conference rooms, lobbies and offices.
      d. Wrap chillers and pumps where located adjacent to noise sensitive rooms.

B. Manufacturers: Kinetics Noise Control #KNM-100ALQ, or equal by BRD Noise and Vibration Control, GLT Products #Vinaflex with Absorber/Decoupler, or Singer Safety Company, Quilted Fiberglass Panels.

C. Composite material, quilted, with reinforced aluminized-face, mass loaded limp vinyl bonded to scrim-face, quilted fiberglass absorber/decoupler.

D. The barrier shall be constructed of a 0.12” (3 mm) minimum, thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a minimum weight of 1.0 lbs./ft^2 (4.9 kg/m^2) and shall have a minimum STC rating of 28 as measured in an independent accredited acoustical laboratory in accordance with ASTM E90 and/or E413.

E. The decoupling layer shall be a combination of 1.0” (25 mm), minimum, fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4” (100 mm) diamond stitch pattern which encapsulates the glass fibers.

F. The composite material shall be fabricated to include a minimum 2” (50 mm) wide barrier overlap tab extending beyond the quilted fiberglass to facilitate a leak-tight seal around field joints.

G. The barrier shall have a Flame Spread Index of no more than 10 and a Smoke Development Index of no more than 40 when tested for Surface Burning Characteristic per ASTM E84.

2.09 ELECTRICAL

A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
3. Set and align all motors and drives in equipment specified herein.
4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.
5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted “U” cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling and shall meet the requirements of the State Industrial Safety Regulations.
6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

B. Quality Assurance:
1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:
1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.
2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors 3/4 HP and larger shall be rated for 3-phase operation above 200

volts. Unless otherwise noted on plans, all motors up to 1/2 HP shall be rated for 120-volt, single phase operation.

4. Temperature Rating: Motor meets class B rise with class F insulation.
5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design “B”, except “C” where required for high starting torque.
   a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
   b. VFD driven motors to be provided as inverter ready and equipped with a shaft grounding device.
   c. Bearings:
      1) Ball or roller bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
      4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
      5) Enclosure type for various applications:
         (a) Open drip-proof (ODP) motors for indoor use in clean air environments.
         (b) Totally enclosed fan cooled (TEFC) motors for outdoor use and indoor application in dirty environments.
         (c) Totally enclosed air over (TEAO) motors for motors in the airstream of cooling towers and fluid coolers.
         (d) Explosion proof motors where motor is located in environments with hazardous or flammable quantities of vapors, gases, mists or dusts or where motor is located inside ductwork or cabinets with hazardous vapors, gases, mists or dusts that exceed 25 percent of the lower flammability limit.
         (e) Guarded drip-proof motors where exposed to contact by employees or building occupants.
         (f) Weather protected Type I for outdoor use, Type II where not housed.
         (g) Electronically commutated motor (ECM) for indoor use in clean air environments.
   d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
   e. Noise Rating: “Quiet.”
   f. Efficiency:
      1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
      2) And, motors shall meet the NEMA premium efficiency standard.
   g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:
   1. Motor Starter Characteristics:
      a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.

b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).

3. Magnetic Starters:
   a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
   c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
   d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
   e. Externally operated manual reset.
   f. Under-voltage release or protection for all motors over 20 hp.

4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:
   1. General: 14-gauge, Type THHN, color coded, installed in conduit.
   2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:
   1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “OPEN” position; arc quenchers; capacity and characteristics as indicated.
   2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or as approved by Owner’s Representative.

3.02 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
   1. If the contractor must deviate from the manufacturer's recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.03 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost. Coordinate wall and ceiling work with the General Contractor, and other trades in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.04 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with the General Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where Gypcrete is indicated, install reinforcing bars through opening at top of inserts. Inserts and anchors shall be located no closer than 6" to any edge and no closer than 1" from any pre-tension cables or embedded steel and as required per manufacturer's instructions and Structural Engineer.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, rails, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers and rails where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install pipe supports (hangers, rails, etc.) within 12 inches of every change in piping direction (only one support required at each change in direction), end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Supports (hangers, rails, etc.) shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one support is required.

F. Install hangers, rails, and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Support sprinkler piping and gas independently of other piping.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

I. Hanger Spacing in accordance with following minimum spans for support of individual pipes. Install a minimum of one hanger within 12” of each change of direction (only one required on either side of elbow), at the end of deadend pipe runs and within 36” of every piece of equipment. For straight runs of horizontal piping with no concentrated loads such as valves, flanges, expansion joints, or other components. Sections of piping with concentrated loads will have to be considered carefully and a determination made as to appropriate spacing and rod size for the given situation. Other spacing and rod sizes may be considered in compliance with Table 121.5 of ASME B31.1, ANSI/MSS SP-58 Table 4, and local mechanical code, but shall not exceed 12 feet for any pipe size. Comply with more restrictive requirements of local codes where those exceed the following minimum criteria.

1. Steel Pipe:

Steel Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
1/2" to 1”	7 feet	3/8”
1-1/4” to 2-1/2”	10 feet	3/8”
3” to 4”	12 feet	3/8”
5” to 8”	12 feet	1/2"
10” to 12”	12 feet	5/8”
14” to 16”	12 feet	3/4"

2. Copper Pipe:

Copper Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
1/2"	4 feet	3/8”
3/4” to 2”	6 feet	3/8”
2-1/2” to 4”	8 feet	3/8”
5” to 8”	8 feet	1/2"

3. Plastic/Fiberglass Pipe:

Plastic/Fiberglass Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
Up to 1”	3 feet	3/8”
1-1/4” to 2-1/2”	4 feet	3/8”
3” to 8”	4 feet	1/2"

4. Trapeze support: Provide details stamped by a Registered Structural Engineer for the project state indicating trapeze channels, support rod sizes, and spacing.
5. Maximum threaded rod loading: Below are maximum loads for hanger rods based on ASHRAE Fundamentals Handbook (Pipe Design Chapter) and ASTM A36, with a safety factor.

Maximum Allowable Loading Capacity for Hanger Rod in Tension	
Nominal Rod Diameter	Load (Maximum Weight)
3/8”	610 pounds
1/2"	1,130 pounds
5/8”	1,810 pounds
3/4"	2,710 pounds
7/8”	3,770 pounds
1”	4,960 pounds

J. Provisions for Movement:
   1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
   3. Insulated Piping: Comply with the following installation requirements:
      a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
      b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
      c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

K. Installation of Anchors:
   1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
   2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
   3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
   4. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends.

L. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

M. Equipment Supports:
   1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction. Coordinate

size of concrete pads and placement of anchors bolts with structural design. Anchor bolts shall be placed to maintain 6", minimum, or greater distance from concrete pad edges.

2. Provide structural steel stands to support equipment above floor mounted or suspended from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

N. Adjusting:
   1. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments.
   2. Support Adjustment: Provide grout under supports to align piping and equipment to proper level and elevations.
   3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

O. Upper Building Attachments: Powder-actuated fasteners may be used where appropriate for construction materials to which hangers are being attached per the following:
   1. Maximum allowable tension load shall not exceed 50 lbs. (0.2 kN) per attachment.
   2. May only by used to supporting for ductwork up to two (2) square feet (0.2 m^2) in cross sectional area and for control conduit clips.
   3. May <u>not</u> be used for support of any piping, equipment, or ductwork greater than two (2) square feet (0.2 m^2) in cross sectional area.
   4. Use concrete inserts before placing concrete in new construction.
   5. Install powder-actuated concrete fasteners after concrete is placed and completely cured to concrete compressive strength of 4000 psi or greater.
   6. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
   7. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
   8. Do not use powder-actuated concrete fasteners for seismic restraints.

3.05 WALL, FLOOR, AND ROOF PENETRATIONS

A. All pipe and duct penetrations through rated and non-rated assemblies shall be sized to allow for compliance with structural integrity and fire ratings, as applicable. Penetrations of fire-resistance-rated assemblies shall be protected by an approved firestop system installed and tested in accordance with ASTM E814 or UL 1479. The system shall have an F rating/T rating of not less than the required rating of the floor or wall penetrated. Where sleeves are required, the sleeve size shall be installed with the inside clear diameter providing clearances as required below. Coordinate the required opening sizes with the manufacturer of the fire protection products.
   1. Uninsulated pipe penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1" (minimum) to 2" (maximum) larger than the outside diameter of each uninsulated pipe.
   2. Insulated pipes penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1" (minimum) to 2" (maximum) larger than the outside diameter of each pipe, including insulation.
   3. Uninsulated pipe penetrations through fire rated walls and floors, and through roof: penetration sizes shall be a 1/2" (minimum) to 1-1/2" (maximum) larger than the outside diameter of each uninsulated pipe to provide minimum 1/4"

annular space between the outside of the pipe surface and assembly. Coordinate with specific manufacturer requirements and UL listing.

4. Insulated pipe penetrations through fire rated walls and floors, and through roof: pipe penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than the outside diameter of each insulated pipe to provide minimum 1/4” annular space between the outside of the insulation surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
5. Uninsulated pipe penetrations through foundation and basement walls: penetration sizes shall be larger than the outside diameter of each uninsulated pipe to allow adequate space for installation of mechanical link seals. Coordinate with specific manufacturer requirements.

3.06 ROOF CURBS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed, as applicable.

C. Verify roof insulation thickness and adjust height of perimeter cant strips to accommodate insulation and roofing material installation.

D. Provide rigid insulation, minimum 1” thick, on exposed elements of roof curb.

E. Provide additional rigid insulation inside the roof curb perimeter secured to roof surface, around ductwork penetrations, to match the adjacent roof insulation levels (same R-value or greater).

3.07 EQUIPMENT RAILS AND PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed, as applicable.

C. Verify roof insulation thickness and adjust height of perimeter cant strips to accommodate insulation and roofing material installation.

3.08 ELECTRICAL COORDINATION

A. Division 23 installers shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the drawings and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements.

C. Division 23 has responsibilities for electrically powered mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings as follows:
   1. Motors: Furnish and install all motors necessary for mechanical equipment.
   2. Magnetic Starters: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
   3. Variable Frequency Drives: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   4. Disconnects: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   5. Controls: Division 23 Contractor (including the Building Automation System (BAS) Controls subcontractor) is responsible for furnishing the following equipment in its entirety. This equipment includes but is not limited to the following:
      a. Additional control panels beyond what is identified on drawings shall be provided by BAS contractor in order to provide a complete control system at no additional cost to Owner.
      b. Control relays necessary for controlling Division 23 equipment.
      c. Control transformers necessary for providing power to controls for Division 23 equipment.
      d. Line voltage thermostats.
      e. Low or non-load voltage control components.
      f. Remote bulb thermostats.
      g. Non-life safety related valve or damper actuators.
      h. Float switches.
      i. Solenoid valves.
      j. Switches.
      k. Refrigeration controls.
      l. Communications wiring and conduit between control devices and mechanical equipment. Control wiring gauge in stranded or solid wire configuration shall be the responsibility of the contractor to coordinate with manufacturers for allowable lengths and load requirements to assure complete and operational systems.
      m. Raceway to support control cabling.
   6. Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
      a. Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for use by Division 28 in providing proof of closure.
      b. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed in ductwork by Division 23 but wired to the damper controller by Division 26.

D. Division 26 Electrical Responsibilities:
   1. BAS Controls Contractor shall initiate and coordinate a meeting with the Electrical Contractor and General Contractor to coordinate all BAS component locations and wiring requirements prior to start of construction. All additional costs associated with lack a coordinated shall be the responsibility of the BAS Contractor at no additional cost to the Owner.
   2. Additional power requirements, including conduit and wiring, for additional or relocated control panels and devices shall be coordinated and the responsibility of the BAS Controls Contractor at no additional cost to Owner.
   3. Motors: Provide the power wiring for the motors from servicing panel to motor controller.
   4. Magnetic Starters: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring from source panel/disconnect to the starter.
   5. Variable Frequency Drives: Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 23.
   6. Disconnects: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition, provide power wiring between motor and disconnect when the disconnect is not factory installed.
   7. Controls: Division 26 is responsible for providing power to mechanical control panels and provide final power connection to Division 23 provided control transformers.
   8. Fire/Smoke Dampers: Division 26 is responsible for power wiring to each damper and as follows:
      a. Where these dampers are part of an integrated smoke control system Division 28 is responsible for providing the detectors and for all fire/smoke detection system wiring necessary to integrate dampers and related end switches into the system.
      b. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct smoke detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed by Division 23, but wired for damper control by Division 26.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.09 FIELD PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1.

Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black.

B. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:
   1. Exposed copper piping.
   2. Aluminum jacketed outdoor insulated piping.

3.10 FACTORY PAINTING

A. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120°F (50°C), the factory painting system must be designed for the temperature service.

3.11 COASTAL OR MARINE ENVIRONMENTS

A. Coastal and marine environments are characterized by the abundance of sodium chloride (salt) which is carried by sea spray, mist or fog. Salt spray can be carried several miles by ocean breezes and tidal currents, often up to five (5) miles from the coast. As a result, protection of HVAC equipment from ocean-borne electrolytes is necessary to assure long equipment life. Line-of-sight distance from the ocean, prevailing wind direction, relative humidity, wet/dry time, and coil temperature will determine the severity of corrosion potential in the coastal environment. If the condenser coils or evaporator coils face the ocean or faces into the prevailing winds from the coast, there is a higher probability of seawater contamination.

B. Coils shall have a flexible epoxy polymer electrostatic coating uniformly applied to coil and fin surface areas with no materiel bridging between fins. Coating shall be applied in factory, not field applied. The coating process will ensure complete coil encapsulation and a uniform dry film thickness from 0.6 to 1.2 mils on all surface areas including fin edges and meet 4B to 5B rating crosshatch adhesion per ASTM B3359. Corrosion durability will be confirmed through testing to no less than 5,000 hours salt spray resistance per ASTM B117 using scribed aluminum test coupons. Coating shall be applied to all coils rated for air flows greater than 3,000 cfm.

C. Equipment cabinets shall be coated with painted on all sides of metal skin and framing elements. No exposed metal is allowed. Coating shall be applied in factory, not field applied. The paint shall be applied using powder coating or spray epoxy as required to meet a 5,000-hour salt spray resistance per ASTM B117.

3.12 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:

      Near each valve and control device.

      a. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
      b. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
      c. At access doors, manholes, and similar access points which permit view of concealed piping.
      d. Near major equipment items and other points of origination and termination.
      e. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room.
      f. Vertically spaced at each story transversed.

C. Ductwork Identification: A minimum of every 50' for all ductwork, 12" or more in diameter or width, where ducts are concealed above accessible ceilings.

D. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
   1. Main control and operating valves, including safety devices.
   2. Meters, gauges, thermometers, and similar units.
   3. Pumps.
   4. Fans.
   5. Hot water system mixing valves and similar equipment.
   6. Balancing dampers and mixing boxes.
   7. Packaged HVAC central-station and zone-type units.
   8. Tanks and pressure vessels.
   9. Strainers, filters, treatment systems and similar equipment.

E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

F. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.

3.13 VIBRATION AND DYNAMIC BALANCING

A. All equipment submitted and installed by Division 23 shall not exceed maximum tolerances as specified by the “International Research and Development Corporation”, Worthington, Ohio, measured by the displacement, peak to peak, as follows:
   1. All Fans: Below severity chart labeled “FAIR”, maximum velocity of 0.0786 in/sec, peak.
   2. Pump and Electric Motors: Below severity chart labeled “SLIGHTLY ROUGH”, maximum vibration velocity of 0.157 in/sec, peak.
   3. Compressors: Same as pumps.

B. Where installed equipment noise or vibration is objectionable to the Owner’s Representative, it shall be responsibility of the contractor to conduct testing to confirm that the equipment does not exceed the standard.

C. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.14 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Owner’s Representative, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Ductwork: Test all air quantities as specified in Section 230593 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.

C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 230593 – Testing, Adjusting and Balancing.

D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.

E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer's representative shall perform all tests.

END OF SECTION

SECTION 23 05 48 - VIBRATION ISOLATION FOR PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SUMMARY

A. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

C. All mechanical equipment, piping and ductwork as noted on the equipment schedule, in the specification or as required by code shall be designed to resist seismic forces. Refer to Section 230549 Seismic Restraint for Piping, Ductwork and Equipment

D. This Section includes the following:

1. Vibration isolation curbs, pads and mounts.
2. Flexible ductwork connectors
3. Spring hangers with and without vertical-limit stops.
4. Spring isolators.
5. Restrained uni-directional seismic isolation snubber mounts.
6. Housed seismic spring vibration mounts.
7. Elastomeric hangers.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Air-mounting system.
11. Restrained vibration isolation roof-curb rails.
12. Seismic snubbers.
13. Vibration isolation equipment bases.
14. Flexible piping connectors

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods.

B. Section 23 0549: Seismic Restraint for Piping, Ductwork and Equipment.

1.04 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.

C. CBC: California Building Code with Amendments.

D. IBC: International Building Code with State Amendments.

E. ICC-ES: ICC-Evaluation Service.

1.05 CODES AND STANDARDS

A. Provide components conforming to the load requirements of the latest addition of the local building code and the following:

1. International Building Code with AHJ Amendments
2. American Society of Civil Engineers (ASCE):
    a. ASCE 7-16 (Latest Edition): Minimum Design Loads for Buildings and Other Structures.
3. The Manufacturers Standardization Society (MSS):
    a. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
    b. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
    c. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices
    d. MSS SP-127: Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.
4. Mason West Inc. Seismic Restraint Guidelines 2014 Edition
    a. For all suspended piping, suspended ductwork and suspended electrical raceways.

1.06 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Refer to Section 23 0549 Seismic Restraint for Piping, Ductwork and Equipment for seismic specific requirements.
2. Vibration isolators must be rated for the seismic loading associated with the system and forces calculated for this building location. Seismic forces for new installations are determined per ASCE 7. Refer to Structural Design for seismic factors and design criteria. Select and

submit appropriate values for each piece of equipment and sub-system and material type for the project, and base the seismic calculations on these values.
3. Coordinate all seismic and load requirements with the registered professional Structural Engineer.

B. Component Importance Factor:
1. Ip=1.0: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
2. Ip=1.5: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category; or Hospitals and Correctional Treatment Centers. Components include, but are not limited to the following:
   a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.
   b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.

1.07 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Building Structural Limits: The design of supports and restraints shall not exceed the building structure allowable point loads. Coordinate all work with the registered professional Structural Engineer.

D. Special Inspections: Provide structural design and Special Inspections as required by Chapter 17 of the IBC, the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. Per IBC Section 1705 all anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner’s Representative.

1.08 WARRANTY

A. Provide minimum one-year warranty requirements, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

1.09 SUBMITTALS

A. Product Data shall include the following:

1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
    a. List showing the equipment and piping to be isolated, the isolator type and model number selected, isolator loading, the actual deflection, isolator free height and installed height. The list must also reference a specific drawing showing frame construction when applicable. For steel spring isolators include solid height and diameter of spring coil.
3. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
4. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
2. Provide all details of suspension and support for ceiling hung equipment.
3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint the locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

C. Manufacturer Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads. Provide base with level top surfaces with integral sloping on bottom to match support structure.

D. Coordination Drawings: Show coordination and plan locations of vibration isolation for HVAC ductwork, piping, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Structural Engineer.

F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent test agency.

G. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

H. WARRANTY

I. Refer to section 23 0500 for basic warranty requirements.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:

1. Standard paint applied to factory-assembled equipment before shipping.
2. Powder coating on springs and housings.
3. All hardware shall be galvanized or powder coated.
4. Hot-dip galvanized or powder coating of metal components for exterior use.
5. Baked enamel or powder coat for metal components for interior use.

B. Glumac Device Key Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with mechanical equipment found on this project. The tag designation of preferred devices is as follows:

Glumac Isolator Tag	Description
P-1	Vibration isolation waffle pad
P-2	Double deflection neoprene mount
P-3	Uni-directional restrained neoprene snubber mount
P-4	Interlocking uni-directional snubber
S-1	Open spring vibration isolator

Glumac Isolator Tag	Description
S-2	Steel housed seismic spring vibration isolator
S-3	Bellows air spring isolator
S-4	Restrained air spring isolator
C-1	Seismic spring isolation roof curb (20 ton HVAC and below)
C-2	Seismic spring isolation roof curb (Greater than 20 ton HVAC)
C-3	Curb mounted spring isolation roof base
B-1	Integral equipment and motor base
B-2	Integral equipment and motor base
B-3	Concrete filled steel inertia base
H-1	Spring and rubber in shear vibration isolation hanger
G-1	All-directional pipe anchor
G-2	Vertical pipe guide
G-3	Horizontal thrust restraint
SB-1	Sway bracing
F-1	Kevlar/rubber spherical type flexible piping coupling
F-2	Stainless hose flexible piping coupling
F-3	Flexible expansion joints
F-4	Flexible ductwork connector

2.02 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Vibrex (OPM #0203-13)
2. Mason (OPM #0043-13)
3. ISAT (OPM #0403-13)

B. P-1 Style: Neoprene pads shall consist of a 3/4" (19 mm) thick neoprene pad molded in square waffle modules, a minimum 1/4” (6 mm) thick steel load distribution plate and 3/4” (19 mm) hole with a neoprene anchor bolt bushing with a flat washer face. Pads may be single or multiple layers as required for leveling. Manufacturers: Mason #MBSW Series or equal.

C. P-2 Style: Restrained bridge bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Manufacturers: Mason #BR Series, VMC Group #YRSM3 Series, or equal.

D. P-3 Style: All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.

Bushing shall be replaceable and a minimum of 1/4” (6 mm) thick. A minimum air gap of 1/8” (3 mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. No sharp edges such as bolt threads may come in contact with the neoprene bushing. Snubber end caps shall be removable to allow inspection of internal clearances. Manufacturers: Mason #Z-1225 Series or equal.

E. P-4 Style: All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19 mm) thick. Rated loadings shall not exceed 1000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3 mm) and not more than 1/4" (6 mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9 mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" (12 mm) deflection in the x, y and z planes. Manufacturers: Mason #Z-1011 Series or equal.

F. S-1 Style: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Two base plate holes for attachment to support surface. Manufacturers: Mason #SLFH Series or equal.

G. S-2 Style: Restrained spring mountings shall include springs that are free standing and laterally stable and complete with a molded neoprene cup or 1/4" (6 mm) neoprene acoustical friction pad between the spring and the mounting base plate. All spring assemblies shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8” (9 m) shall be maintained around restraining bolts so as not to interfere with the spring action. Manufacturers: #SLR Series or #SLRS Series for steel/wood connections and Mason #SLREBP Series or #SLRSEBP Series or #SSLFH Series for concrete connections, or equal.

H. S-3 Style: Multiple bellow air springs shall be manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. All air spring systems shall be equipped with three (3) leveling valves connected to the

building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Manufacturers: Mason #MT and leveling valves Mason #LV, or equal.

I. S-4 Style: Restrained mountings shall include multiple bellow air springs manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. Burst pressure must be a minimum of three (3) times the published maximum operating pressure. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8” (9 mm) shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall have test reports or calculations certifying the maximum allowable horizontal and vertical load ratings. All air spring systems shall be equipped with three (3) leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8" (3 mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves. Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Manufacturers: Mason #SLR-MT for steel connections and Mason #SLREBP for concrete connections and leveling valves Mason #LV, or equal.

2.03 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-1) (HVAC UNITS 20 TON AND UNDER CAPACITY)

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Vibrex (OPM #0203-13)
2. Mason (OPM #0043-13)
3. ISAT (OPM #0403-13)

B. C-1 Style: Curb mounted rooftop equipment shall be mounted on spring isolation curbs. Curbs shall consist of continuous sheet metal frames above and below isolators. Isolators shall be adjustable, free-standing and laterally stable and include a 1/4” (6 mm) acoustical neoprene cup and leveling bolt. Spring diameters shall be no less than 0.8 of the compressed height of the spring at the rated load with 50% additional travel to solid. Seismic snubbers with an all directional neoprene bushing and 1/4” (6 mm) air gap shall be incorporated into each corner. A continuous sheet metal flashing shall be attached to the upper frame and be separated from the lower frame by a neoprene weatherseal. The sheet metal flashing shall incorporate removable cover plates for adjustment and inspection of isolators after the unit is set. The unit must be solidly fastened to the top steel frame and the lower sheet metal curb must be attached to the roof structure. Manufacturers: Mason #ISC Series or equal.

C. C-3 Style: Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the rigid roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal. Aluminum members shall house electro-galvanized or powder coated springs selected for 0.75” (20 mm) minimum deflection. Travel to solid shall be 1.5” (40 mm) minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4” (6 mm) so as not to interfere with the spring action except in high winds. Manufacturer’s self adhering closed cell sponge gasketing must be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM ductlike closure. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Manufacturers: Mason #CMAB Series or equal.

2.04 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-2) (HVAC UNITS OVER 20 TON CAPACITY)

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Vibrex (OPM #0203-13)
2. Mason (OPM #0043-13)
3. ISAT (OPM #0403-13)

B. C-2 Style: Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4" (6 mm) thick. Steel springs shall be laterally stable and rest on 1/4" (6 mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" (50 mm) of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail, and the lower Z section anchored to the roof structure. Manufacturers: Mason #RSC Series or equal.

2.05 VIBRATION ISOLATION STEEL EQUIPMENT BASES

A. Basis-of-Design Product: Subject to compliance with requirements provide a comparable product by one of the following:

1. Vibrex (OPM #0203-13)
2. Mason (OPM #0043-13)

3. ISAT (OPM #0403-13)

B. B-1 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded structural steel angle or channel members. Manufacturers: Mason #MSL Series or equal.

C. B-2 Style: Vibration isolation manufacturer shall furnish integral structural steel bases designed to prevent excessive base flexure at start up, prevent misalignment of equipment and provide attachment points for seismic restraints. Bases shall be rectangular in shape and constructed of welded wide flange structural steel main members with cross bracing located at or near each restraint location. Where height saving brackets are required, they shall be employed in all mounting locations to maintain a 1" (25 mm) clearance below the base. Manufacturers: Mason #WFSL Series or #TSLR Series, or equal.

D. B-3 Style: Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows and shall be 6” deep for pumps through 75 hp and 10” deep for pumps 100 hp through 250 hp. Forms shall include minimum concrete reinforcing consisting of #4 bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Manufacturers: Mason #BMK Series or #KSL Series or equal.

2.06 SPRING HANGERS

A. H-1 Style: Spring hangers shall consist of rigid steel frames containing minimum 1-1/4” (32 mm) thick neoprene elements at the top and steel springs that are free standing and laterally stable seated in a steel washer reinforced neoprene cup at the bottom. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have a neoprene bushing projecting through the steel box. A seismic rebound washer made of steel and surrounding neoprene shall be provided. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 arc from side to side before contacting the rod bushing and short circuiting the spring. Manufacturers: Mason #RW30N Series or equal.

2.07 PIPE GUIDES AND SUPPORTS

A. G-1 Style: All-directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 1/2" (12 mm) thick 60 durometer neoprene. Vertical

restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. Manufacturers: Mason #ADA Series or equal.

B. G-2 Style: Vertical sliding pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (20 mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of 1-5/8" (41 mm) upwards or downwards motion, or to meet location requirements. Manufacturers: Mason #VSG Series or equal.

C. G-3 Style: Horizontal thrust restraints shall consist of a spring element seated in a steel washer reinforced neoprene cup at the bottom, in series with a molded neoprene element. Steel springs shall be free standing and laterally stable. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6 mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Manufacturers: Mason #WBI Series or #WBD Series or equal.

2.08 SWAY BRACING

A. SB-1 Style: Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles or struts. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of two (2). Brace end connections shall be steel assemblies that swivel to the final installation angle. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. Do not mix cable and steel braces to brace the same system or equipment. Manufacturers: Mason #SCB Series or #SCBH Series, steel brace assemblies shall be Mason #SSB Series, #SSBS Series or #SHB Series, and rod clamps shall be Mason #SRC Series or #UCC Series or equal.

2.09 FLEXIBLE PIPING CONNECTORS

A. F-1 Style: Flexible spherical expansion joints for pump connections. Shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes

3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5-minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Manufacturer shall provide pre-stretching charts for expansion joints when used in conjunction with isolated equipment. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Manufacturers: Mason #SAFEFLEX SFDEJ Series, #SAFEFLEX SFEJ Series, #SAFEFLEX SFDCR Series or #SAFEFLEX SFU Series and Control Rods Mason #CR, or equal.

B. F-2 Style: Flexible stainless-steel hose shall have stainless steel braid and carbon steel fittings.

1. Sizes 1/2" (15 mm) to 2” (50 mm):
    a. EPDM or Kevlar core hose with stainless steel braid and brass end fittings. Swivel union ends for threaded nipples or copper sweat ends. Minimum 175 psig working pressure rating. Operating temperature range from 32°F to 225°F (0°C to 107°C). Hoses must have sufficient length, minimum 12” (300 mm) long, to accept 1/2” (12 mm) intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Manufacturers: IMI #Versaflow, Nexus #UF Series, Pro Hydronic Specialties, Titus, Victaulic, Hays Fluid Control, or equal.
2. Sizes 2-1/2” (65 mm) and larger:
    a. EPDM, Kevlar or corrugated stainless-steel core hose with stainless-steel braid. Threaded, flanged or brazed weld ends. Minimum 200 psig working pressure rating. Operating temperature range from 32°F to 225°F (0°C to 107°C). Manufacturers: Mason #FFL Flanged, #CPSB Copper, #CSAMN Threaded, or equal.

C. F-3 Style: Flexible 60° Vee or U-bend braided hose across building or expansion joints. Piping and equipment connections shall be protected against seismic damage by the insertion of braided flexible hose Vee assemblies rated for ±4” (100mm) seismic motion

in all planes. Should the application include ±6” (150mm) thermal movement or thermal movement alone, install the Vee so the thermal movement is axial. Vees shall have a minimum burst pressure of four times their rated pressure. Vees in steel lines shall have stainless hose and braid. Copper lines, bronze hose and braid. Guiding and anchoring shall be as recommended by the manufacturer. Manufacturers: Mason #VFL flanged braided steel Series, #VMN Threaded Braided Stainless Steel Series or #VCPSB Copper Sweat Series, or equal.

2.10 FLEXIBLE DUCTWORK CONNECTORS

A. F-4 Style: Flexible ductwork connection fabricated of fiberglass canvas with fire resistant rated neoprene and UV resistant coating. Stainless steel metal edge banding.

B. Flexible Connections (Indoor Applications):

1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
2. Neoprene (polychloroprene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.
3. Shall be airtight, watertight and fire retardant.
4. Minimum density of 30 oz. per sq. yard.
5. Temperature range: -40°F to 200°
6. Neoprene-only connectors are not allowed.
7. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal.
8. Manufacturers: Ventfabrics #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

C. Flexible Connections (Outdoor Applications):

1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
2. Hypalon (chlorosulfurated polyethylene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.
3. Shall be airtight, watertight and fire retardant. Resistant to sunlight, ozone and weather.
4. Minimum density of 26 oz. per sq. yard.
5. Temperature range: -50°F to 275°F
6. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal.
7. Provide flexible cloth insulating blanket to encase flexible connections to maintain ductwork insulation integrity as follows:
    a. Jacket shall be UV and ozone resistant with Velcro attachment.
    b. Service Operating Temperature: 0-350°F.
    c. Jacket and Liner: silicon or teflon impregnated fiberglass or mineral wool cloth.
    d. Insulation: Aerogel, 2” thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
    e. Fastening: 2” Nomex Velcro or 1” straps and stainless steel D-rings.
    f. Thread: Kevlar/stainless steel thread.

g. Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, or equal.

8. Manufacturers: Ventfabrics #Ventlon or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

2.11 BRACING DEVICES FOR EQUIPMENT, PIPING, AND DUCTWORK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Vibrex (OPM #0203-13)
2. Mason (OPM #0043-13)
3. ISAT (OPM #0403-13)

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least two (2) times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4” (6 mm) thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.

F. Bushings for Floor-Mounted Equipment Anchorage: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.01 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

A. The following Tables provide schedules for minimum vibration devices required for isolation of mechanical equipment provided on the project. Refer to Part 2 above for device specifications. Coordinate with additional requirements recommended by device manufacturers. Sizes show below take precedent as the minimum requirements. Use the greater of the sizes shown as follows or shown on the drawings.

B. Equipment Isolation:

TABLE 1: EQUIPMENT ISOLATION SCHEDULE

EQUIPMENT TYPE	EQUIPMENT LOCATION								
	ROOF AND FLOORS ON GREATER THAN 30' FLOOR SPAN (5)			UPPER FLOOR UP TO 30' FLOOR SPAN (5)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
FLOOR MOUNTED									
Up to 15 HP	S-1 (1)	1.5	B-1 (1)/B-3	S-1 (1)	0.75	B-1	S-1 (1)	0.75	NA
20 HP & Over	S-1 (1)	2.5	B-1 (1)/B-3	S-1 (1)	1.5	B-2	S-1 (1)	0.75	NA
SUSPENDED (4)									
Up to 15 HP	H-1	1.75	B-1(1)/B-3	H-1	1.0	B-1	H-1	1.0	NA
20 HP & Over	H-1	2.5	B-1 (1)/B-3	H-1	1.75	B-1	H-1	1.0	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer factory installed.
(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer's recommendation
(4) For pipe and duct connections provide F-2 pipe and F-4 duct connectors.
(5) Span is the beam or girder distance between columns or exterior fixed wall supports.

C. Exhaust fan (EF-1 thru EF-11) shall be isolated on spring curb isolation system and shall have 2" min deflection. Mason RMS or equal.

1. Type CMS is a prefabricated spring isolation curb for rooftop equipment. The lower member shall consist of a rectangular steel tube containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4 inch thick. Steel springs shall rest on 1/4 inch thick neoprene acoustical pads. Hardware must be cadmium plated or galvanized and the springs plated or provided with an approved rust resistant finish. Weatherproofing shall be provided by a continuous flexible aluminum seal joined at the corners by a flexible frictionless neoprene bellows. The aluminum seal must be nailed over and provide flashing to the curb's waterproofing. Provision shall be made for access ports with waterproof covers at the spring location and 2 inch thermal insulation on the sides of the lower curb.

D. Unhoused Fans, Built-up Systems or Cabinet Fans Equipment Isolation:

TABLE 2: EQUIPMENT ISOLATION SCHEDULE – UNHOUSED FANS, BUILT-UP SYSTEMS, OR CABINET FANS

EQUIPMENT TYPE	EQUIPMENT LOCATION								
	ROOF AND FLOORS ON GREATER THAN 30' FLOOR SPAN (5))			UPPER STORY UP TO 30' FLOOR SPAN (5)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
CENTRIFUGAL FANS									
CL I & II Up to 54-1/2" WD									
Up to 15 HP	S - 2/S - 1	1.5	B-1/B-3	S-2/S-1	0.75	B-1	S-2/S-1	0.75	B-1
20 – 50 HP	S-2	2.5	B-2	S-2/S-1	1.5	B-2	S-2/S-1	0.75	B-1
60 HP & Over	S-2	3.5	B-2	S–2	2.5	B-2	S-2/S-1	1.5	B-1
CL I &II 60"W.D & Over/All CL III Fans									

Up to 15 HP	S-2	2.5	B-2	S-2/S-1	1.5	B-1	S-2/S-1	0.75	B-1
20 – 50 HP	S-2	2.5	B-2	S-2	2.5	B-1	S-2/S-1	1.5	B-1
60 HP & Over	S-2	3.5	B-2	S-2	2.5	B-1	S-2/S-1	1.5	B-1
AXIAL FLOWFANS									
Floor Mounted									
Up to 15 HP	S-1/S-2	1.5	B-1/B-3	S-1	0.75	B-1	S–1	0.75	NA
20 HP & Over	S - 2	3.5	B-2	S-1	1.5	B-2	S-1	0.75	NA
Suspended									
Up to 15 HP	H - 1	1.75	B-1/B-3	H-1	1.0	B-1	H–1	1.0	NA
20 HP & Over	H - 1	2.5	B-1/B-3	H-1	1.75	B-1	H-1	1.5	NA
UTILITY FAN SETS									
Floor Mounted	S - 2/S - 1	1.5	B-1/B-3	S-1	0.75	B-1	S-1	0.75	NA
Suspended	H-1	1.75	B-1/B-3	H-1	1.0	B-1	H-1	0.75	NA
CABINET FANS and FAN SECTIONS									
Floor Mounted									
Up to 15 HP	S-1(1)	1.5	NA	S-1	0.75	NA	S-1	0.75	NA
20 HP & Over	S-2(1)	2.5	B-2	S-1	1.5	NA	S-1	0.75	NA
Suspended									
Up to 15 HP	H-1	1.75	NA	H-1	1.0	NA	H-1	0.75	NA
20 HP & Over	H-1	2.5	NA	H-1	1.75	NA	H-1	1.75	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer.
(2) Provide full perimeter steel welded frame below equipment.
(3) Provide support per manufacturer's recommendation.
(4) For pipe and duct connections provide F-2 pipe and F-4 duct connectors.
(5) Span is the beam or girder distance between columns or exterior fixed wall supports.

E. Pumps – Equipment Isolation

TABLE 3: EQUIPMENT ISOLATION SCHEDULE – PUMPS

EQUIPMENT TYPE	EQUIPMENT LOCATION								
	ROOF AND FLOORS ON GREATER THAN 30' FLOOR SPAN (5)			UPPER FLOOR UP TO 30' FLOOR SPAN (5)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
PUMPS									
Base and Close Coupled Floor Mounted									
Up to 5 HP	S–2/S-1	0.75	B-2	S–2/S-1	0.75	B-1	S–2/S-1	0.4	B-1
7-1/2 HP & Over	S–2/S-1	1.5	B-2	S–2/S-1	1.5	B-2	S–2/S-1	0.75	B-2
Vertical Split Case Floor Mounted									
Up to 5 HP	P-1	0.15	NA	P-1	0.15	NA	P-1	0.15	NA
7-1/2 HP & Over	S–2/S-1	1.5	B-2	S–2/S-1	1.5	B-2	P-1	0.15	NA
Suspended Inline	H-1	1.75	NA	H-1	1.75	NA	H-1	1.0	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer.
(2) Provide full perimeter steel welded frame below equipment.
(3) Provide support per manufacturer's recommendation.
(4) Provide F-1 flexible connector for all pumps larger than ¾ horsepower. Provide F-2 connector for fractional horsepower pumps.
(5) Span is the beam or girder distance between columns or exterior fixed wall supports.

F. Miscellaneous Equipment Isolation

TABLE 5: EQUIPMENT ISOLATION SCHEDULE – MISCELLANEOUS EQUIPMENT

EQUIPMENT TYPE	EQUIPMENT LOCATION								
	ROOF AND FLOORS ON GREATER THAN 30' FLOOR SPAN (5)			UPPER FLOOR UP TO 30' FLOOR SPAN (5)			ON GRADE		
	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
ROOFTOP AIR CONDITIONING UNITS									
Up to 20 Ton	S-2	1.5	C-1/C-3	S-2	1.5	C-1/C-3	NA	NA	NA
Over 20 Ton	S-2	2.5	C-2	S-2	2.5	C-2	NA	NA	NA

Notes:
(1) Alternate: Factory installed by equipment manufacturer.
(2) Provide full perimeter steel welded frame below equipment.
(3) Provide support per manufacturer's recommendation.
(4) For pipe and duct connections to units provide F-2 pipe and F-4 duct connectors.
(5) Span is the beam or girder distance between columns or exterior fixed wall supports.

3.02 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.04 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.

C. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

D. All vibration isolator systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

E. Installation of vibration isolators must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

F. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

G. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the attention of the Owner’s Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

H. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

I. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

J. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

K. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each

vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

L. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.

M. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

N. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

O. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.05 VIBRATION ISOLATION OF PIPING

A. Horizontal Piping: The first three pipe supports from vibration isolated equipment must be vibration isolated to minimize fluid transmitted vibration. The static deflection of the pipe support isolators must be equal to the static deflection for the isolators supporting the connected equipment. Overhead piping shall suspend from Mason Type 30N spring hangers or equal. Floor supported piping shall rest on Mason Type SLR isolators or equal. Refer to contract drawings for additional vibration isolation requirements for piping. Where piping connects to mechanical equipment install Mason Type SFDEJ or SFU expansion joints or Mason Type FFL stainless hoses if Type SFDEJ or SFU is not suitable for the service.

B. Riser isolation: Risers that experience excessive thermal expansion shall be suspended from Mason Type 30N spring hangers or supported by Mason Type SLF(H)

spring mountings, anchored with Mason Type ADA(H) anchors, and guided with Mason Type VSG(H) sliding guides. Horizontal pipe runs and branches shall be supported on Mason Type 30N spring hangers for the first three supports from the risers. Steel springs shall be selected to provide a minimum of 0.75"static deflection except in those expansion locations where additional deflection is required to limit load changes to + 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.07 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.08 AIR MOUNTING SYSTEM DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 05 49 - SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SUMMARY

A. This Section includes the following:
   1. Seismic restraint and support of piping, ductwork and mechanical equipment as required by code and as designed by a registered Professional Structural Engineer for each related nonstructural equipment restraint.
   2. Mechanical component supports and the means how they are attached to the mechanical component shall be designed for the forces and displacements determined in ASCE 7 Chapter 13. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the mechanical component.
   3. All ductwork designed to carry toxic, highly toxic, flammable gases or used for smoke control shall be seismically braced regardless of size or location.

1.03 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. ASCE: American Society of Civil Engineers.

C. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers.

D. CBC: California Building Code with Amendments.

E. IBC: International Building Code with Amendments.

F. ICC-ES: ICC-Evaluation Service.

G. Mechanical Attachments: Means by which components or supports of nonstructural components are secured or connected to the seismic force-resisting system of the structure. Such attachments include anchor bolts, welded connections, and mechanical fasteners.

H. Mechanical Supports: Those members, assemblies of members, or manufactured elements, including braces, frames, legs, lugs, snubbers, hangers, saddles, or struts, and associated fasteners that transmit loads between nonstructural components and their attachments to the structure.

I. Mechanical Components: Elements, including, but not limited to, pumps, air handling units, boilers, chillers, pipes, ductwork, and exhaust fans.

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods.

B. Section 23 0548: Vibration Isolation for Piping, Ductwork and Equipment.

C. Section 23 2113: Hydronic Piping, Valves and Specialties.

D. Section 23 3113: Air Distribution.

E. Other Division 23 Sections.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Structural Performance: Restraint devices and systems shall withstand the effects of locally defined gravity loads, seismic loads, dead loads, live loads, winds loads and stresses within limits and under conditions indicated per the local building code and ASCE 7. Coordinate all support structures and restraint systems with project registered professional Structural Engineer.

C. Special Inspections: Provide structural design and Special Inspections as required in Chapter 17 of the local building code and the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. All anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ but contracted directly with the Owner or Owner’s Representative.

D. Codes and Standards: Provide components conforming to the seismic load requirements of the latest addition of the local building code and the following where applicable:
1. International Building Code with State Amendments

2. ASCE 7-16 (Latest Edition) - Minimum Design Loads for Buildings and Other Structures
   a. Ductwork and piping requirements defined in Chapter 13 Seismic Design Requirements for nonstructural Components.
   b. Seismic Design Categories, D through F, are defined in Chapter 12, Table 12.6-1. While Seismic Design Categories D, E and F may apply to Category I and II buildings not exceeding two stories, light frame construction and/or structures not exceeding 160 in height.
   c. Nonstructural components in Seismic Design Category A are exempt from seismic design requirements.
3. ASHRAE – Practical Guide to Seismic Restraint (Latest Edition).
4. Mason Industries/Mason West - Seismic Restraint Guidelines (Latest Edition).
   a. For all suspended piping, suspended ductwork and suspended electrical raceways.

1.06 APPLICABILITY

A. Seismic restraints are required for nonstructural mechanical systems, but may not be required for the following conditions related to nonstructural components per CBC 1617A.1.18:
   1. Mechanical components in Seismic Design Categories D, E, or F facilities where all of the following apply:
      a. The component Importance Factor, I_p, is equal to 1.0;
      b. The component is positively attached to the structure;
      c. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and any of the following applies:
         1) The component weighs 400 lbs. (1,780 N) or less and has a center of mass located four feet (1.22 m) or less above the adjacent floor level; or
         2) The component weighs 20 lbs. (89 N) or less; or
         3) The distributed ductwork or piping system weights 5 lbs./ft. (73 N/m) or less.

B.
   1. HVACR and other duct systems shall be designed for seismic forces and seismic relative displacements as required in 1617A.1.25 ASCE 7 Section 13.6.6.
   2. Design for the seismic forces and relative displacements of ASCE 7 Section 13.3 shall not be required for duct systems where flexible connections or other assemblies are provided to accommodate the relative displacement between the duct system and associated components, the duct system is positively attached to the structure, or where one of the following apply:
      a. Trapeze assemblies with 3/8-inch or 1/2-inch diameter rod hangers not exceeding 12 inches in length from the duct support point to the connection at the supporting structure are used to support duct, and the total weight

supported by any single trapeze is less than 10lb/ft and 100 pounds or less; or

b. The duct is supported by individual rod hangers 3/8-inch or 1/2-inch in diameter, and each hanger in the duct run is 12 inches or less in length from the duct support point to the connection at the supporting structure, and the total weight supported by any single rod is 50 pounds or less.

3. Design for the seismic forces and relative displacements of ASCE 7 Section 13.3 shall not be required where provisions are made to avoid impact with other ducts or mechanical components or to protect the ducts in the event of such impact, the distribution system is positively attached to the structure; and HVACR ducts have a cross-sectional area of less than 6 square feet and weight 20lb/ft or less.
4. Components that are installed in line with the duct system and have an operating weight greater than 75 pounds, such as fans, terminal units, heat exchangers and humidifiers shall be supported and laterally braced independent of the duct system, and such braces shall meet the force requirements of Section 13.3.1. Components that are installed in line with the duct system, have an operating weight of 75 pounds or less, such as small terminal units, dampers, louvers and diffusers, and are otherwise not independently braced shall be positively attached with mechanical fasteners to the rigid duct on both sides. Piping and conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate the seismic relative displacements of Section 13.3.2.

C. Seismically restrained piping systems shall not move more than 2” during a seismic event and shall not impact the building structure or other nonstructural components during a seismic event. The design force of restraint elements shall be doubled (2 x Fp) to allow for movement up to 2” per ASCE 7 Section 15.7.4.

1.07 PERFORMANCE REQUIREMENTS

A. Component Importance Factor and Risk Category:
1. Ip=1.0: Standard Occupancies and components associated with Risk Category I, II, and III, including offices and schools.
2. Ip=1.5: Components associated with Risk Category IV Buildings (Essential Services); or for conditions outlined in ASCE 7 Section 13.1.3 regardless of Risk Category, or Hospitals and Correctional Treatment Centers. Components include, but are not limited to, the following:
a. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems.
b. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the AHJ and is sufficient to pose a threat to the public if released.
3. Additions, alterations, and repairs involving nonstructural mechanical components in structures designed in accordance with pre-1973 building codes may have a Component Importance Factor of Ip=1.0. However, components

required to operate for life-safety purposes after an earthquake, including emergency and standby power systems, mechanical smoke removal system, fire alarm panels and egress stairways shall have an Ip=1.5.

B. Building Seismic Design Category:
1. The directions of application of seismic forces used in the design shall be those which will produce the most critical load effects. Seismic Design Categories are classified as E. Refer to Structural Designs for project specific classification.

C. Mechanical Seismic Coefficients for Mechanical Components:
1. Refer to ASCE 7 Table 13.6-1 for a_p factor (component amplification factor) and R_p factor (component response modification factor) as required for each unique mechanical component.

1.08 SUBMITTALS

A. Product Data:
1. Include rated load, rated deflection, and overload capacity for each device or system.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service or agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Submit seismic brace product details from the Mason West Seismic Restraint Guidelines detailing compliance with the specifications.
4. Where products from the Mason West Seismic Restraint Guidelines cannot be used, special details must be submitted for approval.

B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Seismic restraint details are shown on construction documents.
2. Calculations must be stamped by a registered professional Structural or Civil Engineer.
3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
5. Provide flexible joints, supports and piping joints as required to accommodate movement across seismic expansion joints and vertical building drift between floors.

1.09 ENGINEERED PIPING SYSTEMS

A. Where the piping system design indicated on the plans utilizes Mason Industries, Inc. - Mason West, Inc. seismic restraint components, vibration isolators, guides, anchors, expansion compensators and flexible connectors the following requirements apply:
   1. Mason Industries, Inc. - Mason West, Inc. products must be installed as shown.
   2. If product substitutions or design changes are made the contractor must provide certified design of the piping system and meet the following conditions:
      a. Certification must be provided by a registered professional Structural Engineer.
      b. Certification shall include a statement that all systems have been checked for loads and stresses and that no excessive loads or stresses exist.
      c. Forces on all anchors, guides, supports, and restraints must not exceed those shown in the original design unless the structure is checked for the larger loads at no cost to the owner.

1.10 MANUFACTURER AND CONTRACTOR RESPONSIBILITIES

A. All seismic restraints shall be designed by a registered professional Structural Engineer.

B. Seismic restraint layouts for piping and ductwork shall be added to the contractor's shop drawings and shall include:
   1. The number, size and location of seismic braces.
   2. Maximum support loads and seismic loads at the seismic brace locations.
   3. Reference to specific details or pages from the Mason West Seismic Restraint Guidelines.

C. Submit seismic restraint layout drawings and special details for approval of the project registered professional Structural Engineer per the requirements listed in the Mason West Seismic Restraint Guidelines.

D. Seismic restraint layout drawings shall bear the stamp and signature of the registered professional Structural Engineer who designed the layout of the braces.

1.11 LOADS ON STRUCTURE

A. The responsibility of determining allowable loads on the structure is the sole responsibility of the project registered professional Structural Engineer.

B. Maximum support loads and seismic brace loads on the structure must be less than the maximum allowable loads defined by the project registered professional Structural Engineer, as shown on the plans.

C. Where maximum loads are not listed on the plans or the maximum allowable loads cannot be met, any additional support steel required to reduce support and seismic

bracing loads on the structure shall be designed by the project registered professional Structural Engineer.

D. Mechanical component supports and the means how they are attached to the component shall be designed for the forces and displacements determined in ASCI 7 Section 13.3.1 and 13.3.2. Such supports include structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as a part of the mechanical component.

E. Mechanical supports are those members, assemblies of members, or manufactured elements, including braces, frames, legs, lugs, snubbers, hangers, saddles, or struts, and associated fasteners that transmit loads between nonstructural components and their attachments to the structure.

F. Mechanical attachments are the means how components or supports of nonstructural components are secured or connected to the seismic force-resisting system of the structure. Such attachments include anchor bolts, welded connections, and mechanical fasteners.

1.12 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 INTENT

A. All seismic restraints described in this section shall be the product of a single manufacturer.

B. Refer to Section 23 0500 for additional guidelines for applicable supports and anchors.

C. Mason Industries products are the basis of these specifications; products of other manufacturers may be submitted for review provided their systems strictly comply with the specifications. Manufacturers: Mason Industries, Hilti Inc., B-Line/Tolco (Eaton), Anvil, Superstrut, or equal.

2.02 SEISMIC SWAY BRACING

A. Seismic sway braces shall consist of galvanized steel aircraft cables, steel angles or steel struts.

B. Cable braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads. Brace end connections shall be steel assemblies that swivel to the final installation angle.

C. Cable brace assemblies shall have published strength and stiffness ratings based on testing per FM-1950 standards.

D. Angle or strut bracket assemblies shall be FM Approved except as noted below.

E. Steel angles or struts, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps.

F. Cable and universal swivel sway brace bracket attachment assemblies shall be Mason Industries #SCB or #SCBH, or equal.

G. Solid and swivel brace bracket assemblies shall be Mason Industries #Type SSB or #SSBS, or equal.

H. Rod clamps shall be Mason Industries #SRC or #UCC, or equal.

I. Hanging Cables with Adjustable Fastener: Wire rope hangers for maximum point loads not exceeding 100 lbs. (45 Kg) for supporting rigid galvanized ductwork and suspended diffusers/grilles/terminal units.
   1. Wire Rope: High tensile steel wire rope, to ASTM 1023/1023M, class A zinc coating; 7 by 7 or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi (1,770 N per sq. mm); lengths, diameters, and wire construction to accommodate design loads and as indicated on Construction Shop Drawings.
   2. Adjustable Fastener: Mild steel (type EN1A), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 100 lbs. (45 kg) (maximum per hanger).
   3. Manufacturers: Gripple #Standard No. 2/3/4/5, Ductmate #Clutcher, or equal.

PART 3 - EXECUTION

A. Contractor’s Statement of Responsibility: Each contractor responsible for installing a Designated Seismic System or any seismic resisting component must submit a statement of responsibility prior to the commencement of work to include acknowledgment of awareness of the need for Special Inspections.

B. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

C. Installation of seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

D. No connections between the piping or ductwork and the building structure shall be made that degrades the seismic restraint system herein specified.

E. Any conflicts with other trades due to inadequate space or other unforeseen conditions should be brought to the attention of the Owner's Representative prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 WORK RELATED IN OTHER SECTIONS

A. Section 23 0500: Basic HVAC Materials and Methods.

B. Section 23 0900: Building Automation System (BAS) Controls.

C. Section 23 2113: Hydronic Piping, Valves and Specialties.

D. Section 23 3113: Air Distribution.

E. Division 26: Electrical.

1.03 SUMMARY

A. Scope: Extent of testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section, and Section 23 0500 -Basic Mechanical Requirements.

B. Systems: Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:
   1. Air handling systems including supply, return and exhaust.
   2. Air distribution ductwork including supply, return and exhaust.
   3. Dedicated exhaust systems.
   4. Building automation system controls.
   5. Instruction of Owner's personnel for future balancing of systems.

1.04 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Reference Standards
   1. ANSI/ASHRAE Standard 111 - Measurement, Testing, Adjusting and Balancing of Building HVAC Systems (current edition).
   2. ASHRAE - HVAC Applications Handbook: Chapter 38 - Testing, Adjusting and Balancing (current edition).
   3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings, Chapter 6 (current edition).

4. AABC - National Standards for Total System Balance.
5. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
6. SMACNA - HVAC Systems-Testing, Adjusting and Balancing.
7. SMACNA - HVAC Air Duct Leakage Test Manual.
8. ANSI - American National Standards Institute. Comply with the following:
   a. S1.4: Specifications for Sound Level Meters.
   b. S1.11: Specifications for Electroacoustics - Octave-Band and Fractional-Octave-Band Filters
9. Building Code, with State Amendments, Chapter 9 Fire Protection Systems.
10. Mechanical Code, with State Amendments, Chapter 4 Ventilation Air Supply.
11. Local Nonresidential Energy Code.

1.05 QUALITY ASSURANCE

A. Contractor’s Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, is not the installer of the system to be tested and is otherwise independent of the project. Testing, adjusting, and balancing shall be performed by a certified NEBB technician or a certified AABC technician under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor. Testing and balancing agency must submit qualifications for review and approval prior to acceptance for work.

B. Penalty: The Contractor shall submit the name of the organization he proposes to employ for approval within 30 days after contract award. If the Contractor fails to submit the name of an acceptable agency within the specified time, a firm may be selected to accomplish the work, and this selection shall be binding upon the Contractor at no additional cost.

C. Retainages: In addition to any other sums retained or withheld pursuant to the provisions of this Contract, the amount of dollars will be withheld from payments to the contractor until such time as the work has been completed and accepted. In no event will this amount be paid to the Contractor prior to 60 days following acceptance of the project; during such time, the Contractor shall investigate and correct any reported deficiencies unless such deficiencies are a result of unauthorized tampering by building occupants.

D. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 6 months.

E. Testing and balancing agency, as part of its contract, shall act as authorized inspection agency responsible to Consulting Engineer and Owner, and shall list all items that are installed incorrectly, require correction, or have not been installed in accordance with contract Drawings and Specifications, pertaining to air distribution, cooling and heating systems. The testing and balancing agency is required to provide written reports of all deficiencies and proposed recommendations to the Owner' Representative, Contractor, Architect and Engineer.

F. The testing and balancing agency shall provide with their bid a performance guarantee covering all phases of the work as herein specified.

G. The General and Mechanical Contractors shall cooperate with the selected testing and balancing agency in the following manner:
   1. Provide sufficient time before final completion dates so that tests and balancing can be accomplished.
   2. The various system installers, suppliers and contractors shall provide all required materials, labor and tools to make corrections when required without undue delay. Install balancing dampers and valves as required by testing and balancing agency.
   3. The contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.
   4. Testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with a complete set of Record Drawings.
   5. The General Contractor shall make space and other facilities available to the testing and balancing agency to enable their work to progress. The General Contractor shall schedule the work of other trades to avoid conflicts with this work.

H. All air balancing work shall be coordinated with other disciplines to comply with the meet or exceed the minimum requirements of the Americans with Disabilities Act (ADA), Building Code, local amendments and State Energy Code.

1.06 SUBMITTALS

A. Conform to the Submittals requirements of Division 01.

B. Forms: The Contractor shall deliver a complete copy of either NEBB or AABC standard forms for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are not acceptable.

C. Test Reports: Provide six (6) certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include key plans identifying all inlets and outlets. Final test reports shall be typed. Handwritten reports are not acceptable.

D. Maintenance Data: Include, in maintenance manuals, copies of certified and approved test and balance reports and identification of instruments.

E. Qualifications: The Test and Balance Agency shall submit qualifications of all persons responsible for supervising and performing the on-site testing and balancing work and the name of the certifying agency, NEBB or AABC. Provide a reference list of five (5) similar size projects with contact person and telephone number.

1.07 AGENDA

A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.

1. Review plans and specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.
2. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas such as conference rooms.
3. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.
4. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:
    a. Air terminal configuration.
    b. Flow direction (supply or exhaust).
    c. Velocity corrections.
    d. Effective area applicable to each size and type of air terminal.
    e. Density corrections.
5. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.

1.08 JOB CONDITIONS

A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.
    1. Installation and start-up work on equipment or systems to be tested has been completed and documented.
    2. Work area scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.
    3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested shall be in their completed normal positions and operation.
    4. All related mechanical systems which may affect the operation of the system to be tested shall be at their normal operating conditions.

PART 2 - PRODUCTS

2.01 TEST HOLES

A. Test holes and ports shall be provided in ducts, housings and pipes as directed by the Balancing Agency. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.

2.02 PATCHING MATERIALS

A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.
    1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2. Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

2.03 TEST INSTRUMENTS

A. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. The Owner's Representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

B. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against Certified Calibrated instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.

C. Cone Instruments: The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser/grille/register air flow measurements. The readout meters shall meet calibration requirements.

PART 3 - EXECUTION

3.01 PROCEDURES AND INSTRUMENTS, GENERAL

A. Requirements: All systems and components thereof shall be adjusted to perform as required by approved project drawings and specifications.

B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four-hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air quantities measured during such tests.

C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.
1. All instruments shall be applied in accordance with the manufacturer's certified instructions.
2. All labor, instruments, and appliances required shall be furnished by the Contractor. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

3.02 DUCT SMOKE DETECTORS

A. Duct smoke detectors shall be provided and located as required by these specifications and drawings and as required by the building codes and the following:
1. Obtain information from the Contractor who is to furnish the smoke detectors on the proper device placement and installation limitations and on the proper differential pressure across the sampling tubes of the duct detectors and for required air velocity range requirements.

2. Installing Contractor shall review the manufacturer's installation guidelines for proper mounting locations.
3. The testing and balancing agency shall be engaged to confirm that proposed mounting locations will not be adversely impacted by airflows.

B. Duct smoke detectors shall be tested in collaboration with the installing Contractor and project Fire Alarm Contractor to ensure proper air flow sampling and differential pressure.

3.03 DUCTWORK AIR LEAKAGE TESTING

A. Dust leakage testing is required on all ductwork constructed to 4” wg class and higher.

B. Test and balance agency shall perform active air flow testing of ductwork systems or sections of ductworks. Agency shall inspect and confirm that all ductwork is sealed per the specification requirements prior to performing any testing. Calculate maximum allowable air leakage by system based on total design air flow rate and/or square footage of ductwork. Maximum allowable system air flow leakage shall not exceed 5% of total air volume, or the maximum allowable per local energy or mechanical codes where the allowable limit is less than 5%.

C. Representative sections totaling 10 percent, or greater, of the total installed duct area shall be tested. Where the tested 10 percent fails to comply with the requirements, then 40 percent of the total installed duct area shall be tested. Where the tested 40 percent fails to comply then 100 percent of the total installed duct area shall be tested and verified to have a leakage rate that does not exceed the maximum allowable limit. Duct sections shall be selected by the Owner’s Representative. Obtain total duct surface area and air flow volumes for each duct section from the installing contractor. Positive pressure leakage testing shall be permitted for negative pressure ductwork.

D. Additional ductwork leakage testing may be required to meet local energy and mechanical code requirements. Refer to local codes for applicability and requirements.

E. Ductwork systems to be leakage tested and procedures shall include:
1. Testing shall be performed at 1.5 times the peak design outlet static pressure (external static pressure) from the air handling unit/fan, but not greater than the maximum SMACNA pressure rating of the ductwork construction classification.
2. Testing is not required of flexible ductwork.
3. Leakage through manufactured products, such as air handling units, dampers, fire/smoke dampers and terminal units may be excluded from the leakage calculations based on manufacturer stated values, at pressure, or these units may be temporarily sealed with painter’s tape or plastic sheeting during testing to seal any openings and must be removed after testing.
4. Supply air ductwork from the outlet of the air handling unit/fan to inlet side of terminal units or connection to flexible ductwork. Duct leakage testing is not required downstream of terminal units.
5. All supply, return and exhaust air ductwork located outside the building envelope.

6. Return and exhaust air ductwork located in unconditioned spaces from inlet of the air handling unit/fan to the ductwork terminations upstream of each return air grille.

F. For buildings under the jurisdiction of the UMC or CMC provide duct leakage testing in compliance with maximum allowable leakage quantities per code Section 603 and in no case greater than 5% of the total system air flow volume. Ductwork shall be leak-tested in accordance with the procedures described in SMACNA HVAC Air Duct Leakage Test Manual. The permitted duct leakage shall be not more than the following:
   1. $L_{MAX} = C_L P^{0.65}$ where:
      a. L_{MAX}=maximum permitted leakage (ft^3/min/100 sf [0.0001 (m^3/s)/m^2] duct surface area.
      b. $C_{L=}$ Six (6), SMACNA duct leakage class (ft^3/min/100 sf [0.0001 (m^3/s)/m^2] duct surface area at 1 inch water column (0.2 kPa).
      c. P=test pressure, which shall be equal to the design duct pressure class rating in inches of water column (kPa).

G. Additional leakage testing in California, per the energy code, requires that duct systems shall be sealed to a leakage rate not to exceed 6% of the fan flow if the duct systems are:
   1. Connect to a constant volume, single zone system, air conditioners, heat pumps or furnaces, and,
   2. Serve less than 5,000 square feet of floor area, and
   3. Have more than 25% duct surface area located in one or more of the following places:
      a. Outdoors, or,
      b. In a space directly under a floor where the U-factor of the roof is greater than the U-factor of the ceiling, or,
      c. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or,
      d. In an unconditioned crawlspace, or,
      e. In other unconditioned spaces.

H. Ductwork installer shall prepare ductwork for pressure testing as deemed appropriate to maintain construction schedule. Ductwork may be tested as total systems or in sections. Sectional testing will require documentation to prove the totalized system leakage is within allowable range of entire system. Ductwork inlets and outlets may be temporarily sealed airtight with plastic, or other means, to facilitate testing pressures.

I. Testing may occur through ductwork devices such as balancing dampers, smoke fire dampers and coils. Manufacturer provided air leakage allowances for such devices may be excluded from duct leakage measurement but must be documented in final report.

J. The leakage rate shall be confirmed through field verification and diagnostic testing in accordance with procedures defined by Oriflow Air Leakage Test, or equivalent procedure. Perform all testing utilizing a duct leakage testing system, Oriflow Duct Leakage Tester or equal, with calibrated fan, orifice, gauges, ductwork, pressure tips and tubing.

3.04 AIR SYSTEM PROCEDURES

A. Adjustments: Adjust all air handling systems to provide design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant air conditions.

B. Equalizers: Equalizing devices shall be adjusted to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.

C. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).
   1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.
   2. Restriction imposed by flow regulating devices in or at terminals shall be minimal.
   3. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air pattern of diffusion and as indicated on the air distribution drawings.

D. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 0.5” w.g. and sound level criteria are met.

E. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.
   1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."
   2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses, airflow in the duct shall be determined by totaling volume of individual terminals served, measured as described herein.
   3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.

F. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.

G. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda. Laboratory tests shall be conducted to prove accuracy of testing

methodology and test data when so directed. Such tests shall be conducted in conformance with applicable ASHRAE or American Society of Mechanical Engineers (ASME) codes and shall be performed at no additional cost to Owner.

H. Air Motion: Air motion and distribution shall be as specified and indicated on drawings. The Contractor, at no additional cost to the Owner shall, in addition to air motion and direct measurements, perform smoke tests as requested to demonstrate the air distribution and pattern from air terminals and outlets.

I. Air system test and balance procedures shall include, but not be limited to the following requirements:
   1. Test and adjust blower RPM to design requirements.
   2. Test and record motor full load amperes.
   3. Make pitot tube traverse of main supply ducts and obtain design CFM at fans.
   4. Test and record system static pressures, suction pressure directly at system fan inlet, and outlet pressure directly at system fan outlet or discharge. Test and record static pressure across each component of air handling system (coils, filters, etc.).
   5. Test and adjust system for design CFM recirculated air.
   6. Test and adjust system for design CFM outside air.
   7. Test and record entering air temperatures.
   8. Test and record leaving air temperatures.
   9. Adjust all supply, return and exhaust air ducts to proper design CFM.
   10. Adjust all zones to proper design CFM, supply and return.
   11. Test and adjust duct systems and each diffuser, grille, and/or register to within 10% of design requirements.
   12. Each grille, diffuser and register shall be identified as to location and area.
   13. Operate each variable frequency drive (VFD) and verify controls installation is complete.
   14. Size, type and manufacturer of VAV boxes, diffusers, grilles, registers and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
   15. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustment.
   16. In cooperation with the control manufacturer's representative, setting adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Testing agency shall check all controls requiring adjustment by control installers. Room thermostats shall be checked for cooling and heating response.
   17. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
   18. Adjust overall system balances to allow all self-closing exterior doors to close from any open position. Maximum interior air pressure in all operational modes shall not exceed 0.05" static pressure relative to the outside air pressure. Comply with chapter 10 of the Building Code to assure that self-closing doors will release with a maximum force of 15 pounds.
   19. As part of the work of this contract, the HVAC contractor shall make any changes in the pulleys, belts and dampers or the addition of dampers required for correct balance as recommended by air balance agency, at no additional cost to Owner.

20. After air balancing is completed and RPM determined, HVAC Contractor shall provide fixed pitch pulleys.
21. All mixing boxes, control dampers, smoke dampers and similar devices which operate at 100% shut off shall be tested for leakage.

3.05 ADA COMPLIANCE

A. All air balancing work shall be coordinated with other disciplines to comply with meeting or exceeding the minimum requirements of the Americans with Disabilities Act (ADA), Building Code, State Energy Code and local amendments. Final air balancing for all systems in each space shall be verified and adjusted as necessary to meet the following requirements during peak ventilation, smoke control mode, partial ventilation and minimum ventilation modes during occupied and non-occupied hours. The following requirements are provided as consolidated list of minimum ADA requirements:
   1. The required force for pushing or pulling open a door other than fire doors shall not exceed 5 pounds.
   2. At fire doors the required opening force shall not exceed 15 pounds.
   3. At fire doors the doors shall be set in motion when subjected to a force not exceeding 30 pounds.
   4. At fire doors the doors shall swing to a full open position when subjected to a force not exceeding 15 pounds.
   5. The force to operate door latch releases shall not exceed 5 pounds.
   6. The differential pressure between the building lobby and outside shall remain positive between 0.01” w.g., minimum, and 0.05” w.g., maximum, during operational hours.

3.06 AIR SYSTEM DATA

A. Report: The certified report shall include for each air handling system the data listed below.
   1. Equipment (Fan or Factory Fabricated Station Unit):
      a. Installation data
         1) Manufacturer and model
         2) Size
         3) Arrangement, discharge and class
         4) Motor hp, voltage, phase, cycles, and full load amps
         5) Location and local identification data
      b. Design data
         1) Data listed in schedules on drawings and specifications.
      c. Fan recorded (test) data
         1) CFM
         2) Static pressure (suction and discharge, across each coil and filter set)
         3) RPM
         4) Motor operating amps
         5) Motor operating bhp
   2. Duct Systems:
      a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust:
         1) Duct size(s)
         2) Number of pitot tube (pressure measurements)

3) Sum of velocity measurements (Note: Do not add pressure measurements)
4) Average velocity
5) Recorded (test) cfm
6) Design cfm

b. Individual air terminals
1) Terminal identification supply or exhaust, location and number designation
2) Type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
3) Design and recorded velocities - fpm (state "core," "inlet," etc., as applicable)
4) Design and recorded quantities - cfm (deflector vane or diffusion cone settings)

3.07 SOUND TEST PROCEDURES

A. Scope: Tests of sound levels shall be made at each selection point as described in the following:
1. Each normally occupied room or space, including, but not limited to, the following:
a. Offices, open and enclosed.
b. Conference rooms and breakout rooms.
c. Lobbies and waiting rooms.
d. Break rooms.
e. Retail spaces.
f. Dining area.
g. Hospitality spaces, guest rooms and patient rooms.
h. IT and data equipment rooms.
2. Within five feet of each piece of noise generating equipment, such as chillers, cooling towers/fluid coolers, fans, compressors, pumps, and condensers. Or, within the documented sound measurement distance as listed in the equipment manufacturer literature.
3. Within five feet of property lines where mechanical equipment is located outside the building.

B. Timing: Sound level measurements shall be taken at times when the building is unoccupied, or when activity in surrounding areas and background noise level in areas tested are at a minimum and relatively free from sudden changes in noise levels.
1. Measurements shall be taken with all equipment turned off, except that being tested.
2. The required sound levels shall be measured at any point within a room not less than 6 feet from any equipment or air terminal and not closer than 3 feet from any floor, wall, or ceiling surface.

C. Meters: Sound levels shall be measured with a sound meter complying with ANSI S1.4. The "A" scale shall be used to measure over all sound levels. To determine the specified octave band levels, the above sound level meter, set on "C" scale, shall be supplemented by an octave band analyzer complying with ANSI S1.11.

D. Equipment Components: The "Equipment Component" of room sound equals LPt-C. The "Equipment Component" of room sound (noise) levels shall be determined for each of eight octave bands as follows:
   1. Measure room sound pressure level "LPb" with equipment to be tested shut off.
   2. Measure room sound pressure level "LPt" with equipment to be tested turned on.
   3. Calculate LPt-LPb; if this value is less than 1, applicable test must be rerun with lower background level (LPb) unless LPt is within sound pressure level specified for equipment.
   4. Determine "c" from the table below.

LPt-LPb (db)	c (db)
1	7
2	4
3	3
4 to 4- ½	2
5 to 5- ½	1 – ½
6 to 7- ½	1
8 to 12	½
over 12	0

3.08 SOUND LEVEL DATA

A. Report: Certified report shall record data on sound levels, taken at each selected location, as follows:
   1. Source of sound and location.
   2. Diagram or description of relationship of sound source to measuring instrument.
   3. "A" scale readings equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
   4. Readings at each specified octave band frequency for equipment being tested turned off (ambient level) and equipment being tested turned on (operating conditions).
   5. "Equipment Components" of sound (noise) levels with applicable calculations per "Sound Test Procedures".
   6. Graph showing relationship between pressure levels specified and recorded readings

B. Retest: Subsequent to any correctional construction work, such as acoustic corrections, measurement shall be made to verify that associated air quantities, as previously measured, have not been disrupted.
   1. Certified report shall record all sound data, and their locations, after final adjustments of air systems involves

3.09 BALANCING MEASUREMENT TOLERANCES

A. Comply with codes and standards applicable for this project and local AHJ.

B. Comply with maximum tolerance air balance limitations listed in the ASHRAE Handbook – HVAC Applications (latest edition) and as listed in the following guidelines:
   1. Air terminal units: -2% to +10% of design air flows.
   2. Minimum Outside Air: -2% to +10% of design air flows.
   3. For negative pressure rooms: 0% to +10% or design exhaust air flows and balance supply air from -10% percent to 0% of design supply air flows.
   4. For positive pressure rooms: 0% to +10% of supply air flows and balance exhaust/return form -10% to 0% of design air flows.
   5. For rooms with less than 200 cfm, that are not indicated by plans or code to be positive or negative, balance the supply/return/exhaust from -5% to +5% of design air flows.
   6. Supply fans, return fans, exhaust fans and equipment with fans: 0% to +10% of design air flows.
   7. Air outlets and inlets: -/+ 5% of design air flows.

3.10 CERTIFIED REPORTS

A. Submittals: Six (6) copies of the reports described herein, covering air system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.

B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.

C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and design deficiencies.

D. Certification: Certification shall include checking of adherence to agenda, of calculations, of procedures, and evaluation of final summaries.

3.11 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

A. Scope: Test shall be made to demonstrate that capacities and performance of air systems comply with contract requirements.
   1. At the time of final inspection, the Contractor shall recheck, random selection of data (air quantities, air motion, and sound levels) recorded in the certified report. In addition, all courtrooms, auditoriums, and conference rooms shall be rechecked.
   2. Points and areas for recheck shall be selected by the commissioning team.
   3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.
   4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from design, or a sound level greater than 2 db or more than recorded in the certified report

listings, as 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost. Retainage time shall be based on the date of the final acceptance of the certified report.

C. Marking of Settings: Following final acceptance of certified reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 0500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
   1. Ductwork Insulation:
      a. Duct wrap insulation.
      b. Acoustic duct lining.
      c. Rigid board ductwork and plenum insulation.
      d. Fire Rated duct insulation systems.
      e. Field applied jackets, indoor and outdoor.
   2. Section Includes insulating the following duct services:
      a. All supply air ductwork, unless otherwise shown on drawings.
      b. Return air ductwork in unconditioned spaces and as shown on drawings.
      c. Acoustical duct lining, in vertical/horizontal supply and return ducts within twenty feet (20') of air handling equipment and where otherwise shown on drawings.
      d. Outside air ductwork in return plenums, mechanical rooms and in freezing climates.
      e. Exhaust air ductwork in cold air plenums.
      f. Vapor/moisture ductwork.
      g. Insulation to protect fire rated exhaust systems.
   3. Plenums and equipment rooms, as noted.

B. Types of mechanical insulation specified in this Section include the following:
   1. Duct wrap insulation: Glass mineral wool also known as fiberglass.
   2. Acoustic duct liner: Glass mineral wool also known as fiberglass.
   3. Rigid board duct and plenum insulation: Calcium silicate.
   4. Rigid board duct and plenum insulation: Glass mineral wool.
   5. Fire-rated duct insulation: Fire-rated board.
   6. Fire-rated duct insulation: Fire rated blanket.
   7. Insulation jackets.
   8. Removable covers
   9. Insulation accessories.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods.

B. Section 23 3113: Air Distribution.

1.4 DEFINITIONS

A. Ambient: The air temperature to be maintained in a conditioned room. Typically, between 70°F and 78°F.

B. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.

C. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

D. Freezing Climate: Where outdoor design temperature is less than 33° F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.

E. Unconditioned Space: any space not directly conditioned by mechanical equipment or maintained to temperature by mechanical equipment.

1.5 INSULATION INDUSTRY DEFINITIONS

A. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a Kraft paper interleaving with an outer film layer leaving no paper exposed.

B. ASJ: All Service Jacket (no outer film).

C. EPA: Environmental Protection Agency.

D. FHC: Fire Hazard Classification

E. FSK: Foil-Scrim-Kraft facing or vapor barrier.

F. FSP: Foil-Scrim-Polyethylene facing or vapor barrier.

G. ECOSE Technology: a proprietary binder system based on rapidly renewable bio-based materials, rather than petroleum-based chemicals commonly used in other glass mineral wool insulation materials. ECOSE Technology reduces the binder embodied energy by up to 70 percent and does not contain phenol, formaldehyde, acrylics, or artificial colors.

H. Imperative 11, Red List – requires that manufacturers disclose the ingredients in their products to document they are free of Red List chemicals and materials. The Red List represents the “worst in class” materials, chemicals and elements known to pose serious risks to human health and the greater ecosystem.

I. PSK: Polypropylene-Scrim-Kraft facing or vapor barrier.

J. PVC: Polyvinyl Chloride.

K. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE and Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations.

L. Recycled Content – Post-Consumer: materials such as bottled glass collected at curbside or other collection sites after consumer use and used in the manufacturing process to create a new product rather than being placed in a landfill or incinerated.

M. Recycled Content – Pre-Consumer (aka Post-Industrial): materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process rather than being placed in a landfill or incinerated.

N. SVF: Synthetic Vitreous Fiber including all forms of manufactured inorganic fibrous insulations such as glass wool (fiberglass) and mineral wool (rock wool and slag wool).

O. SSL+: Self-Sealing Lap with Advanced Closure System.

P. SSL: Self-Sealing Lap.

Q. Underwriter’s Laboratories Environment (UL Environment): offers independent green claims validation, product assessment and certification.

R. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL classifies products to applicable UL requirements standards for safety and standards of other National and International organizations

S. UL Environment Claims Validation (ECV): service and label tests a manufacturer’s product and validates that the environmental claims they make in their marketing and packaging materials are factual. This ECV service enables products to qualify for LEED® MR Credit 4 Recycled Content LEED-NC 2009 or New LEED V-4 Building product disclosure and optimization – sourcing of raw materials.

T. UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.

U. UL GREENGUARD Gold Certification: (formerly known as GREENGUARD Children & Schools Certification) offers stricter certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by both The Collaborative for High Performance Schools (CHPS) and the Leadership in Energy Environmental Design (LEED) Building Rating Systems.

V. WHO: World Health Organization.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
      a. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      b. C165: Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
      c. C167: Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
      d. C168: Terminology for Thermal Insulation.
      e. C177: Test Method for Steady-State Heat Flux Measurements and Thermal Transmission by Properties by Means of the Guarded Hot Plate Apparatus.
      f. C195: Specification for Mineral Fiber Thermal Insulating Cement.
      g. C196: Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
      h. C302: Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
      i. C303: Test Method for Density of Preformed Block-Type Thermal Insulation.
      j. C305: Test for Thermal Conductivity of Pipe Insulation.
      k. C356: Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
      l. C411: Test for Hot-Surface Performance of High Temperature Thermal Insulation.
      m. C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      n. C449: Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
      o. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      p. C533: Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      q. C534: Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      r. C547: Specification for Mineral Fiber Preformed Pipe Insulation.
      s. C552: Specification for Cellular Glass Block and Pipe Thermal Insulation.
      t. C612: Specification for Mineral Fiber Block and Board Thermal Insulation.
      u. C755: Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation.
      v. C795: Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      w. C916: Standard Specification for Adhesives for Duct Thermal Insulation.
      x. C921: Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
      y. C1104: Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
      z. C1071: Standard Specification for Thermal and Acoustical Insulation.

aa. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
bb. C1290: Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
cc. C1338: Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
dd. D1667: Standard Specification for Flexible Cellular Material-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
ee. E84: Test Method for Surface Burning Characteristics of Building Materials.
ff. E119: Test for Fire Resistance.
gg. G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
hh. G22: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
ii. EE2336: Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
   a. 90: Energy Conservation in New Building Design.
3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
   a. 255: Test Methods, Surface Burning Characteristics of Building Materials.
4. Underwriters Laboratory (UL): Manufacture and test insulation in accordance with the UL Standards, including:
   a. 181: Standard for Factory-Made Air Ducts and Air Connectors.
   b. 723: Standard for Test for Surface Burning Characteristics of Building Materials.
   c. 2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

D. Flame/Smoke Rating: Materials exposed within ducts or plenums shall be noncombustible. Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method or UL 723. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Discrete plumbing, mechanical, and electrical products that are located in a plenum and have exposed combustible material shall be in accordance with UL 2043.

E. Corrosiveness: Passes ASTM C1617-05, Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals.

F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

G. Sustainable Project Requirements:
   1. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products

1.7 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also, furnish necessary test data certified by an independent testing laboratory. Submit samples.
   1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
      a. Pentabrominated diphenyl ether (CAS#32534-81-9).
      b. Octabrominated diphenyl ether (CAS#32536-52-0).
      c. Decabrominated diphenyl ether (CAS#1163-19-5).
   2. All materials, adhesives, mastics and sealants installed in California shall meet or exceed the minimum testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing and Evaluation of Volatile Organic Emissions from Indoor Sources using Environmental Chambers."

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.9 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIRMENTS

A. Comply with requirements in “PART 3 – EXECUTION” for Table 1, Table 2 and Table 3 for application of insulation materials.

B. Products shall not contain asbestos, lead, mercury or mercury compounds if possible. Products shall be certified UL GREENGUARD Gold or Indoor Advantage Gold if possible.

C. Insulation materials for use on austenitic stainless steel shall be qualified per ASTM C795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Each insulation material has been provided a descriptive key code, such as **DW-A**, to simplify the organization and application of materials in following sub-sections.

F. Acceptable manufacturers include Knauf, Johns Manville, Owens-Corning, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix or equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 DUCT WRAP INSULATION (IDENTIFIED BY KEY CODE DW AND IN TABLE 1)

A. **DW-A,** Flexible Glass Mineral Wool Blanket:
1. Application: Exterior insulation wrap for ductwork or other HVAC systems.
2. Flexible Glass Mineral Wool Blanket bonded with a bio-based thermosetting resin:
3. Comply with ASTM C553, ASTM C1290, UL 723, and UL Greenguard certified.
4. K-value: 0.29 Btu□in./(hr.□ft²□°F) at 75°F installed full thickness (maximum). Equivalent to “R-Value” per inch of 3.4 (hr.□ft²□°F)/Btu□in. (minimum).
5. Density: 0.75 lb./cu.ft. (minimum).
6. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft. Or, PSK (Polypropylene-Scrim-Kraft) plastic vapor barrier.
7. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" section.
8. Maximum operating temperature: 250°F.

9. Flame spread index: ASTM E84, less than 25.
10. Smoke developed index: ASTM E84, less than 50.
11. Manufacturers: Knauf Insulation #Atmosphere Duct Wrap, Owens Corning #SOFTR Duct Wrap, Johns Manville #Microlite FSK or PSK or equal.

B. **DW-B,** Elastomeric Foam Flexible Insulation:
1. Application: Exterior insulation wrap for ductwork or other HVAC systems.
2. Elastomeric foam insulation with acrylic polymer airstream coating.
3. Comply with ASTM D1622, ASTM C1104, ASTM C518, and UL Greenguard Low VOC certified.
4. K-value: 0.25 Btu□in./(hr.□ft²□ºF) at 75°F per ASTM C518. Equivalent to “R-Value” per inch of 4.0 (hr.□ft²□°F)/Btu□in. (minimum).
5. Density: ASTM D 1622, 3.0-6.0 lb./ft3.
6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
7. Fungal and bacteria resistance: ASTM G 21/22, no growth.
8. Maximum operating temperature: 250°F.
9. Flame spread index: ASTM E84, less than 25.
10. Smoke developed index: ASTM E84, less than 50.
11. Adhesive: UL listed waterproof type compliant with ASTM C916.
12. Manufacturers: Armacell #AP Armaflex and #AP Coilflex or equal.

C. **DW-C,** Black PSK-Faced Flexible Glass Mineral Wool Blanket for Visible Exposed Ducts:
1. Application: Exterior insulation wrap for exposed ductwork or other HVAC systems.
2. Flexible Glass Mineral Wool Blanket bonded with a bio-based thermosetting resin:
3. Comply with ASTM C553, ASTM C1290, UL 723, and UL Greenguard certified.
4. K-value: 0.29 Btu□in./(hr.□ft²□°F) at 75°F installed full thickness (maximum). Equivalent to “R-Value” per inch of 3.4 (hr.□ft²□°F)/Btu□in. (minimum).
5. Density: 0.75 lb./cu.ft. (minimum).
6. Vapor Barrier Jacket: Black PSK (Polypropylene-Scrim-Kraft) faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft.
7. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" section.
8. Maximum operating temperature: 250°F.
9. Flame spread index: ASTM E84, less than 25.
10. Smoke developed index: ASTM E84, less than 50.
11. Manufacturers: Johns Manville #Microlite Black PSK or equal.

2.3 ACOUSTIC DUCT LINER (IDENTIFIED BY KEY CODE ADL AND IN TABLE 3).

A. **ADL-A,** Glass Mineral Wool Acoustic Duct Liner:
1. Application: Internal insulated duct lining for acoustic or thermal purposes.
2. Fiberglass acoustical duct liner bonded with a bio based thermosetting resin mat fiber-free facing.
3. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
4. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.

5. K-value: 0.24 Btu□in./(hr□ft²□°F) at 75°F (maximum). Equivalent to "R-Value" per inch of 4.2 (hr.□ft²□°F)/Btu□in. (minimum).
6. Water vapor absorption: ASTM C1104, less than 3% by weight.
7. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.70 based on ASTM C423 Type "A" mounting.
8. Maximum velocity on mat or coated air side: 6,000 ft./min.
9. Surface burning: NFPA 90 A and 90B.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.
12. Smoke developed index: ASTM E84, less than 50.
13. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
14. Manufacturers: Johns Manville #Linacoustic RC, Knauf Insulation #Atmosphere with ECOSE, Owens Corning #QuietR Duct Liner HD or Duct Liner Board or equal.

B. **ADL-D,** Round Duct Liner:
1. Application: Internal insulated round duct lining for acoustic or thermal purposes.
2. Fiberglass acoustical duct liner bonded with a bio based thermosetting resin.
3. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
4. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.
5. K-value: 0.23 Btu□in./(hr□ft²□°F) at 75°F (maximum). Equivalent to "R-Value" per inch of 4.3 (hr.□ft²□°F)/Btu□in. (minimum).
6. Water vapor absorption: ASTM C1104, less than 3% by weight.
7. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.75 based on ASTM C423 Type "A" mounting.
8. Maximum velocity on mat or coated air side: 6,000 ft./min.
9. Surface burning: NFPA 90 A and 90B.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.
12. Smoke developed index: ASTM E84, less than 50.
13. Factory-formed grooves at sufficient intervals to prevent air gaps between back of insulation and spiral duct surface.
14. Manufacturers: Owens Corning #QuietZone Spiral Duct Liner, Johns Manville #Spiracoustic Plus or equal.

2.4 RIGID FIBERGLASS BOARD DUCTWORK AND PLENUM INSULATION (IDENTIFIED BY KEY CODE Rb BELOW AND IN TABLE 2)

A. **RB–A,** Rigid fiberglass duct board:
1. Application: Rigid duct boards for insulating metal plenums and metal ductwork where rigidity is required.
2. Fiberglass duct board with a bio based thermosetting resin.
3. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
4. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.
5. K-value: 0.23 Btu□in./(hr□ft²□°F) at 75°F (maximum). Equivalent to "R-Value" per inch of 4.3 (hr.□ft²□°F)/Btu□in. (minimum).

6. Water vapor absorption: ASTM C1104, less than 3% by weight.
7. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.75 based on ASTM C423 Type “A” mounting.
8. Maximum velocity on mat or coated air side: 6,000 ft./min.
9. Surface burning: NFPA 90 A and 90B.
10. Maximum operating temperature: 250°F.
11. Flame spread index: ASTM E84, less than 25.
12. Smoke developed index: ASTM E84, less than 50.
13. Density: 3.0 lbs./cu ft. (minimum).
14. Vapor Barrier Jacket: ASJ+ (All Service Jacket) or FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft paper.
15. Manufacturers: Knauf #Atmosphere Air Duct Board, Johns Manville #SuperDuct RC, Owens Corning #QuietR Duct Board, Certainteed #Ultra*Duct or equal.

2.5 FIRE-RATED INSULATION SYSTEMS

A. **FRI-C,** Fire-Rated Board:
1. Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700°F (927°C).
2. Comply with ASTM C656, Type II, Grade 6.
3. Compliant with ASTM E119, ASTM E814, UL 263, UL 1479, UL 1709 and NFPA 251 for one and two hour fire protection.
4. Flame spread index: ASTM E84, equal to 0.
5. Smoke developed index: ASTM E84, equal to 0.
6. Density (minimum): 28 lb./cu.ft.
7. “R-Value” per inch thickness (minimum): ASTM C518, 1.7 (hr□ft²□°F) / Btu at 75°F.
8. Manufacturers: Johns Manville #Super Firetemp M or equal.

B. **FRI-D,** Fire Barrier Duct Wrap for ventilation ducts:
1. High-temperature, flexible, blanket insulation with FSK jacket that is NRTL (Nationally Recognized Test Lab) tested and certified to provide a 1-hour or 2-hour fire rating. Apply one layer for ventilation (supply, return, environmental exhaust) ducts and life safety ducts.
2. Compliant with ISO 6944.
3. Density (minimum): 6 lb./cu.ft.
4. Thickness (minimum): 1.5” thick (38 mm).
5. “R-Value” per inch thickness (minimum): ASTM C518, 4.0 (hr□ft²□°F) / Btu at 75°F.
6. Maximum operating temperature: 2192°F (1200°C).
7. Flame spread index: ASTM E84, less than 25.
8. Smoke developed index: ASTM E84, less than 50.
9. Manufacturers: 3M #Fire Barrier Duct Wrap 615+, Morgan #FireMaster FastWrap XL, Morgan #Pyroscat DuctWrap XL, Unifrax #FyreWrap Elite 1.5 or equal.

C. **FRI-E,** Fire Barrier Plenum Wrap for encapsulating non-rated (plastic) pipes and cables:

1. High-temperature, flexible, blanket insulation with FSK jacket that is NRTL (Nationally Recognized Test Lab) tested and certified. Apply one layer blanket to wrap combustible items in an air plenum area.
2. Density (minimum): 8 lb./cu.ft.
3. Thickness (minimum): 0.5” thick (13 mm).
4. Maximum operating temperature: 2300°F (1260°C).
5. Flame spread index: ASTM E84, less than 25.
6. Smoke developed index: ASTM E84, less than 50.
7. Manufacturers: 3M #Fire Barrier Duct Wrap 5A+, Unifrax #FyreWrap 0.5 Plenum Insulation, Morgan #FireMaster PlenumWrap or equal.

2.6 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive:
1. Comply with MIL-A-24179A, Type II, Class I.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
3. Manufacturer: Aeroflex #Aeroseal, Armacell #Armaflex 520, H.B.Fuller #Foster 85-75, K-Flex #720-LVOC or equal.

C. Mineral-Fiber Adhesive:
1. Comply with MIL-A-3316C, Class 2, Grade A.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
3. Manufacturer: H.B.Fuller #Childers Chil-Quik CP-127, H.B.Fuller #Foster 85-60 or 85-75, Mon-Eco Industries # 22 Series or equal.

D. ASJ+ Adhesive, and FSK Jacket Adhesive:
1. Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Manufacturer: H.B.Fuller #Childers Chil-Quik CP-127, H.B.Fuller #Foster 85-60 or 85-75, Mon-Eco Industries #22 Series or equal.

E. PVC Jacket Adhesive:
1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Manufacturer: Dow Corning #739 Plastic Adhesive, Johns Manville #Zeston Perma-Weld, Speedline #Polyco Adhesive Low VOC or equal.

2.7 MASTICS

A. Materials shall be compatible with ductwork material, insulation materials, jackets, and substrates and for sealing joints and seams.

B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   2. Service Temperature Range: -20°F to +180°F (-29°C to +82°C).
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.
   5. Manufacturer: H.B.Fuller #Foster 30-90, Vimasco #749 Vapor-Blok or equal.

D. Vapor-Barrier Mastic: Solvent based; suitable for indoor use.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
   2. Service Temperature Range: 0 to 180°F (Minus 18 to plus 82°C).
   3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   4. Color: White.
   5. Manufacturer: H.B.Fuller #Childers CP-30, H.B.Fuller #Foster 30-35, Mon-Eco Industries #55-10 or equal.

E. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use for below ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104°C).
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.
   5. Manufacturer: H.B.Fuller #Foster 60-95/60-96 or equal.

F. Breather Mastic: Water based; suitable for indoor and outdoor use for above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.
   5. Manufacturer: H.B.Fuller #Childers CP-10, H.B.Fuller #Foster 46-50, Mon-Eco Industries #55-50, Vimasco #WC-1 or WC-5 or equal.

2.8 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 1241°C).
   4. Color: Aluminum.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturer: H. B. Fuller Company #Childers CP-76, Eagle Bridges - Marathon Industries #405, H. B. Fuller Company #Foster 95-44, Mon-Eco Industries, Inc.#44-05 or equal.

B. ASJ+ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturer: H. B. Fuller Company #Childers CP-76 or equal.

2.9 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304, 0.020 inch (0.50 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
4. Manufacturer: ITW Insulation Systems, Gerrard Strapping and Seals, RPR Products #Insul-Mate Strapping or equal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated. Manufacturer: AGM Industries, Inc. #CWP-1, GEMCO #CD, Midwest Fasteners #CD, Nelson Stud Welding #TPA/TPC/TPS or equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer. Manufacturer: AGM Industries #CHP-1, GEMCO #Cupped Head Weld Pin, Midwest Fasteners #Cupped Head, Nelson Stud Welding #CHP or equal.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel coordinated with application, fully annealed, 12 gauge, 0.106-inch-(2.6-mm-) diameter shank, length to suit depth of insulation indicated.

c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
d. Manufacturer: AGM Industries #Tactoo Perforated Base Insul-Hangers, GEMCO #Perforated Base, Midwest Fasteners #Spindle or equal.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   d. Manufacturer: GEMCO #Nylon Hangers, Midwest Fasteners #Nylon Insulation Hangers or equal.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, as coordinated with application. 12-gauge, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
   d. Manufacturer: AGM Industries #Tactoo Self-Adhering Insul-Hangers, GEMCO; #Peel & Press, Midwest Fasteners #Self Stick or equal.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch- (0.41-mm-) thick, galvanized-steel, aluminum or stainless steel sheet, as coordinated with application with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
   b. Manufacturer: AGM Industries #RC-150, GEMCO #R-150, Midwest Fasteners #WA-150, Nelson Stud Welding #Speed Clips or equal.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Manufacturer: GEMCO, Midwest Fasteners or equal.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel

2.10 LAGGING ADHESIVES

A. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

B. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated per 40 CFR 59, Subpart D (EPA Method 24).
   2. Service Temperature Range: 0 to +180°F (-18°C to +82°C).
   3. Color: White.
   4. Manufacturer: H.B.Fuller #Childers CP-50, H.B.Fuller #Foster 30-36, Vimasco #713 or 714 or equal.

2.11 TAPES

A. ASJ+ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf./inch (7.2 N/mm) in width.
   6. ASJ+ Tape Disks and Squares: Precut disks or squares of ASJ+ tape.
   7. Manufacturer: ABI Ideal Tape #428 AWF ASJ+, Avery Dennison Corporation Specialty Tapes Division #Fasson 0836, Compac Corporation #104 and 105, Venture Tape #1540 CW Plus, #1542 CW Plus, and #1542 CW Plus/SQ or equal.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 6.5 mils (0.16 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
   7. Manufacturer: ABI Ideal Tape #491 AWF FSK, Avery Dennison Corporation Specialty Tapes Division #Fasson 0827, Compac Corporation #110 and 111, Venture Tape #1525 CW NT, #1528 CW, and #1528 CW/SQ or equal.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications and UL 723 compliant.
   1. Width: 2 inches (50 mm).
   2. Thickness: 6 mils (0.15 mm).
   3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
   6. Manufacturer: ABI Ideal Tape #370 White PVC tape, Compac Corporation #130, Venture Tape #1506 CW NS or equal.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL181 compliant.
   1. Width: 2 inches (50 mm).
   2. Thickness: 3.7 mils (0.093 mm).
   3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
   6. Manufacturer: ABI Ideal Tape Division #488 AWF, Avery Dennison Corporation #Specialty Tapes Division Fasson 0800, Compac Corporation #120, Venture Tape #3520 CW or equal.

2.12 FIELD APPLIED DUCTWORK INSULATION JACKETS

A. Field Applied Jackets (For Exterior Applications):
   1. Longitudinal seams shall not be located on top of ducts when exposed to outdoor environment. All longitudinal seams shall be located on bottom of ductwork.
   2. Stainless Steel Jacket: Type 304 stainless steel, 0.010” minimum (smooth/corrugated) finish.
   3. Aluminum Jacket: 0.016” aluminum with factory applied moisture barrier positioned such that the longitudinal overlap provides a watershed.
   4. PVC Jacket: Johns Manville #Zeston 300, 30 mil thick, white.
   5. Circumferential joints shall be wide enough to provide weather-proofing jacket.
   6. Secure jacket with 3/8" or 1/2" stainless steel bands on 12” centers for round ductwork and objects.
   7. Secure to rectangular sheet metal with sheet metal screws. Seal screw penetrations with silicone caulk.

B. Field Applied Jackets (For Interior Applications):
   1. All longitudinal seams shall be located on bottom of ductwork.
   2. PVC Plastic: One-piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
   3. Manufacturer: Johns Manville #Zeston 2000 or equal.

2.13 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ+: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ+-SSL: ASJ+ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
   5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.14 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: White.
   3. Manufacturer: Johns Manville #Zeston, P.I.C. Plastics #FG Series, Proto Corporation #LoSmoke, Speedline Corporation #SmokeSafe or equal.

D. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier: 3-mil (0.076 mm) thick polysurlyn.
   2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier: 3-mil (0.076 mm) thick polysurlyn.
   3. Manufacturer: H. B. Fuller Company #Childers Metal Jacketing Systems, ITW Insulation Systems #Aluminum and Stainless Steel Jacketing, RPR Products #Insul-Mate or equal.

E. Self-Adhesive Outdoor Jacket:
   1. 60-mil (1.5 mm) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
   2. Manufacturer: Polyguard Products, Inc. #Alumaguard 60 or equal.

2.15 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 4 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts. Manufacturer: H. B. Fuller Company #Childers Chil-Glas No. 5 or equal.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts. Manufacturer: H. B. Fuller Company #Foster 42-24 Mast-A-Fab, Vimasco Corporation #Elastafab 894 or equal.

2.16 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd. (271 g/sq. m). Manufacturer: Alpha Associates, Inc. #84215/9383 or equal.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that ductwork has been tested for leakage in accordance with specifications before applying insulation materials. All ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:
   1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
   2. Remove and replace any insulation that has become wet or damaged during the construction process.
   3. Continue insulation and vapor barrier at penetrations and duct supports, except where prohibited by code. Instances where this is required include:
      a. Ductwork support angle or struts.
         1) To prevent crushing of low density insulation, provide separator or high density insulation at point of support. A 12 inch wide strip of 6 pcf density, glass mineral wool board or similar manufactured product, across the bottom side of the duct. Vapor barrier to continue unbroken at point of support.
         2) As an alternative method, where the duct sits directly on the Unistrut or similar support, install board material on either side of the support to allow duct wrap to be tented over the support, providing a smooth transition over the support and maintaining thickness. Rigid 3 pcf board may be used in this method.

B. Insulation Applied on the Outside/Exterior of the Duct:
   1. Provide insulated ductwork conveying air below ambient temperature (below room temperature) with vapor retardant jacket.
   2. Seal all vapor retardant jacket seams and penetrations with 3” wide pressure-sensitive vapor barrier tape matching the insulation facing.
   3. Where insulation is required, all ductwork, fittings, dampers, elbows, flexible ducts, rigid and flexible connectors, runouts, and devices shall be continuously insulated from fan systems to inlets/outlets to minimize heat transfer into

ductwork and prevent condensation on exposed surfaces and as required to comply with applicable mechanical code and energy code.

4. Provide insulated ductwork conveying air above ambient temperature (above room temperature) with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.
5. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.
6. For ductwork exposed in mechanical equipment rooms below 7' or in finished spaces, finish with jacket material.
7. For interior vapor/moisture conveying duct applications, install glass mineral wool insulation unless specifically indicated otherwise on drawings. Install to meet manufacturer's requirements and as required by local code authorities.
8. Ducts installed exposed outside the building:
    a. For exterior applications where insulation is on the outside of the duct, provide insulation with a weather protection metal jacket or double wall construction.
    b. All exposed to weather exterior metallic ductwork exposed or covered with cladding is to be built with a crown or reverse cross break to shed moisture.

C. Installation of Mineral-Fiber Insulation (Blanket or Rigid Type):
1. Secure weld pins to duct using adhesive recommended for ductwork material. Pins shall be installed on a minimum of three sides of each duct to assure proper support. For overhead ductwork - pins are not required on the top of the ducts. For underfloor ducts - pins are not required on bottom side of ducts. For vertical ducts - pins are not required on surface facing wall. Install pins as follows:
    a. On duct sides with dimensions 18 inches and smaller: Place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
    b. On duct sides with dimensions larger than 18 inches: Place pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing and reinforcement points.
    c. Pins may be omitted from top surface of plenums.
    d. Do not over compress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
2. Install insulation with a continuous unbroken vapor barrier and insulation butted tight at each joint. Create a facing lap for longitudinal seams and end joints with insulation by removing up to 2 inches from one edge as required to allow stapling. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 6 inch maximum on center. Staples may be omitted when closures are made by machine using heat-sensitive tape. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

3. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
4. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches maximum on center.

D. Duct Liner-Insulation Applied on the Interior of the Duct:
1. Adhere insulation to sheet metal with a UL listed adhesive. Adhesive shall be applied to the sheet metal with a minimum coverage of 90%.
2. Secure insulation with mechanical liner fasteners as indicated by SMACNA or manufacturer. Pin length should be as recommended by the liner manufacturer.
3. All exposed edges of the liner must be factory or field coated. Unless factory coated, all transverse edges and longitudinal joints of the duct liner shall be coated. For systems operating at 2,000 fpm or higher, a metal nosing must be installed in all liner facing fan discharge or upstream of the airflow.
4. Repair liner surface penetrations with UL listed adhesive.
5. Duct dimensions indicated on plans are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.
6. Liner shall be folded and compressed into corners of rectangular duct or cut and fitted to assure a lapped compressed joint. Longitudinal joints should not occur in rectangular duct except at corners.
7. Longitudinal joints shall be coated with adhesive.

3.3 ENCAPSULATING NON-RATED PIPES AND CABLES

A. Where combustible non-fire rated pipes (plastic) and cables are installed in an air plenum space provide one layer of **FRI-E** fire barrier plenum wrap to fully encapsulate the item to comply with ASTM E84 or UL-723.

3.4 DUCTWORK INSULATION SCHEDULES

A. All insulation thicknesses shall meet or exceed latest edition of applicable ASHRAE 90.1, IECC, State Energy Code, Local Energy Code, and State Mechanical Code requirements as noted below. Minimum thermal resistance in range of 4.0 to 4.2 per inch of thickness. Insulation thicknesses are based on glass mineral wool insulation and may be adjusted for equivalent insulation values for materials with superior “K” factors.

B. The installed thickness of duct insulation used to determine its R-value shall be determined as follows:
1. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

C. All air distribution system ducts and plenums, but not limited to, building cavities, mechanical closets, air handler boxes, and support platforms used as ducts or plenums, shall be installed, sealed, and insulated to meet the requirements of the code. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum level of R-8.
   1. Outdoors; or,
   2. In a space between the roof and an insulated ceiling; or,
   3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or,
   4. In an unconditioned crawlspace; or,
   5. In other unconditioned spaces; or,
   6. For buildings subject to compliance with the IECC in any location in Climate Zones 5 through 8 the insulation shall be 3” (R-12) minimum thickness for ductwork exterior to the building envelope.

D. TABLE 1: DUCT WRAP INSULATION SERVICE, THICKNESS, AND MATERIAL TYPE REQUIRED.

TABLE 1: EXTERNAL DUCT WRAP INSULATION			
SYSTEM	R-Value (Minimum)	FINISH/JACKET	INSULATION KEY CODE AND REMARKS
Supply and/or return ductwork located outside to the building envelope.	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	Metal jacket or galvanized sheet metal sandwich (double wall). Refer to drawings. Alternate option: pre-insulated duct system, refer to Section 233113 Air Distribution.	**DW-B, RB-A**. Duct wrap or blanket with fabric or FSK jacket is not allowed.
Supply and/or return ducts within building envelope in unconditioned areas, inside shafts and above ceilings.	R-8	FSK or PSK	**DW-A, B, C**
Supply and/or return duct exposed in the atmosphere controlled occupied space.	R-4.2	Black PSK	**DW-C**
Supply or return duct serving the remote 50 ft. (15 m) of exposed ductwork in the atmosphere controlled occupied space.	NA	NA	Except where noted on drawings for acoustical reasons.
Outside air intake ducts within the building envelope.	R-8	FSK or PSK	**DW-A, B**
Exhaust ducts within 10 ft. (3 m) of exterior openings.	R-4.2	FSK or PSK	**DW-A, B**
Adjust insulation thicknesses as required to meet minimum R-Values.			

E. TABLE 2: DUCTWORK RIGID INSULATION AND PLENUM INSULATION SERVICE, THICKNESS, AND INSULATION TYPE REQUIRED.

TABLE 2: RIGID INSULATION AND PLENUM INSULATION			
SYSTEM	THICKNESS (Minimum)	FINISH/JACKET	INSULATION KEY CODE AND REMARKS
Supply and/or return ducts located outside of the building envelope. Use rigid duct board sandwiched between sheet metal layers.	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	Metal jacket or galvanized sheet metal sandwich (double wall). Refer to drawings. Alternate option: pre-insulated duct system, refer to Section 233113 Air Distribution.	**DW-B or RB-A.** Duct wrap or blanket with fabric jacket are not allowed in this application.
Outside air intake ducts	R-4.2	FSK	**RB-A**. Provide aluminum jacket over exterior installations.
Interior Plenums	R-8	FSK	**RB-A**
Exterior Plenums	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	FSK	**RB-A**
Supply, return and relief ducts in mechanical rooms.	R-8	FSK	**RB-A**
Supply and return ducts routed through parking garages.	R-8	FSK	**RB-A**
Roof curb walls used for supply or return air that aren't pre-insulated by manufacturer.	R-8	FSK	**RB-A**

TABLE 2: RIGID INSULATION AND PLENUM INSULATION			
SYSTEM	THICKNESS (Minimum)	FINISH/JACKET	INSULATION KEY CODE AND REMARKS
Roof surface inside roof curb perimeter and around duct penetrations.	R-8 or greater to match roof insulation value	FSK	**RB-A**
Vapor/moisture ducts installed exterior to the building envelope.	R-4.2	FSK	**RB-A.** Provide jacketing on exterior ducts.
Adjust insulation thicknesses as required to meet minimum R-Values.			

F. TABLE 3: ACOUSTIC DUCT LINER SERVICE, THICKNESS, AND INSULATION TYPE REQUIRED.

TABLE 3: ACOUSTICAL DUCT LINER			
SYSTEM	THICKNESS (Minimum)	FINISH	INSULATION KEY CODE
Where indicated for rectangular supply or return ductwork installed in conditioned areas.	R-4.2 unless otherwise noted on drawings	Air stream side mat or other fiber-free facing	**ADL-A**
Where indicated for rectangular supply or return ductwork installed in unconditioned areas without exterior duct insulation.	R-8 unless otherwise noted on drawings	Air stream side mat or other fiber-free facing	**ADL-A**
Supply and/or return ducts located exterior to the building envelope, where indicated on drawing.	R-8 minimum. For any location in colder Climate Zones 5 thru 8 of the IECC increase thickness to R-12.	Air stream side mat or other fiber-free facing	**ADL-A**
Inside supply and return ducts within 20’ of Air Handling Unit connections.	R-8	Air stream side mat or other fiber-free facing	**ADL-A**
VAV terminal unit outlet plenum	R-4.2 unless otherwise noted on drawings	Air stream side shall be fiber-free with resin mat facing, aluminum or mylar liner, or acrylic polymer facing	**ADL-A**
Inside supply air ducts serving air to food service/kitchen areas.	Not allowed	NA	**NA**

TABLE 3: ACOUSTICAL DUCT LINER			
SYSTEM	THICKNESS (Minimum)	FINISH	INSULATION KEY CODE
Healthcare facilities-supply and return ductwork installed in conditioned areas and as indicated on the drawings.	R-4.2 unless otherwise noted on drawings	Air stream side with cleanable mylar or perforated metal facing	**ADL-A**
Healthcare facilities-supply or return ductwork installed in unconditioned areas without exterior duct insulation.	R-8 unless otherwise noted on drawings	Air stream side with cleanable mylar or perforated metal facing	**ADL-A**
Where indicated for round ductwork installed in conditioned areas.	R-4.2	Air stream side mat or other fiber-free facing	**ADL-D**
Where indicated for round ductwork installed in unconditioned areas without exterior insulation.	R-8	Air stream side mat or other fiber-free facing	**ADL-D**
Adjust insulation thicknesses as required to meet minimum R-Values.			

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 0500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
   1. Piping Insulation:
      a. Piping Insulation.
      b. Insulation Jackets.
      c. Removable Covers.
   2. Acoustic piping wrap
   3. Section includes the following HVAC piping systems:
      a. Valves, pumps, air separators, strainers and fittings in insulated piping systems.
      b. Refrigerant hot gas and suction piping.

B. Types of mechanical insulation specified in this Section include the following:
   1. Glass fiber.
   2. Mineral wool.
   3. Closed cell phenolic.
   4. Polyisocyanurate.
   5. Calcium silicate.
   6. Cellular glass.
   7. Flexible elastomeric closed cell foam.
   8. Aerocel.
   9. Insulation jackets.
   10. Removable covers.
   11. Insulation accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Division 22: Plumbing.

B. Section 23 0500: Basic HVAC Materials and Methods.

C. Section 23 2113: Hydronic Piping, Valves and Specialties.

1.04 DEFINITIONS

A. Ambient: The air temperature to be maintained in a conditioned room. Typically, between 70°F and 78°F.

B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.

C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.

D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.

E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.

F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.

G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

H. Freezing Climate: Where outdoor design temperature is less than 34°F (1°C), as stated in ASHRAE Fundamentals under 99% column for winter design conditions.

I. Unconditioned Space: any space not directly conditioned by mechanical equipment or maintained to temperature by mechanical equipment.

1.05 INSULATION INDUSTRY DEFINITIONS

A. Third Party Independent Product sustainable certification: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.
   1. UL GREENGUARD
   2. Scientific Certification Systems (SCS)

B. EPA: Environmental Protection Agency.

C. WHO: World Health Organization.

D. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.

E. ASJ: All Service Jacket (no outer film).

F. SSL+: Self-Sealing Lap with Advanced Closure System.

G. SSL: Self-Sealing Lap.

H. FSK: Foil Scrim Kraft; jacketing.

I. FSP: Foil Scrim Polyethylene jacketing

J. PSK: Poly Scrim Kraft; jacketing.

K. FHC: Fire Hazard Classification

L. PVC: Polyvinyl Chloride.

M. Bio based Binder Technology: binder systems based on rapidly renewable bio-based materials; rather than petroleum-based chemicals commonly used in other glass mineral wool insulation materials. Biobased Technology reduces the binder embodied energy by up to 70 percent and does not contain phenol, formaldehyde, acrylics or artificial colors.

N. UL GREENGUARD Gold Certification: Certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by the Leadership in Energy Environmental Design (LEED) Building Rating Systems.

O. Recycled Content – Post-Consumer: materials such as bottled glass collected at curbside or other collection sites after consumer use and used in the manufacturing process to create a new product rather than being placed in a landfill or incinerated.

P. Recycled Content – Pre-Consumer (aka Post-Industrial): materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process rather than being placed in a landfill or incinerated.

Q. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE and Deca-BDE fire retardants: have been linked to adverse health effects after exposure in low concentrations.

R. UL Classified: UL has tested and evaluated samples of the product with respect to certain properties of the product. UL classifies products to applicable UL requirements standards for safety and standards of other National and International organizations

S. Imperative 11, Red List – requires that manufacturers disclose the ingredients in their products to document they are free of Red List chemicals and materials. The Red List represents the “worst in class” materials, chemicals and elements known to pose serious risks to human health and the greater ecosystem.

T. Underwriter’s Laboratories Environment (UL Environment): offers independent green claims validation, product assessment and certification.

U. UL Environment Claims Validation (ECV): service and label tests a manufacturer’s product and validates that the environmental claims they make in their marketing and packaging materials are factual. This ECV service enables products to qualify for LEED® MR Credit 4 Recycled Content LEED V-4 Building product disclosure and optimization – sourcing of raw materials.

1.06 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
      a. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plat.
      b. C165: Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
      c. C168: Provides standard terminology for thermal insulation.
      d. C177: Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
      e. C195: Specification for Mineral Fiber Thermal Insulating Cement.
      f. C196: Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
      g. C302: Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
      h. C303: Test Method for Density of Preformed Block-Type Thermal Insulation.
      i. C305: Test for Thermal Conductivity of Pipe Insulation.
      j. C335: Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
      k. C356: Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
      l. C411: Test for Hot-Surface Performance of High Temperature Thermal Insulation.
      m. C423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      n. C449: Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
      o. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      p. C533:Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      q. C534: Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      r. C547: Specification for Mineral Fiber Pipe Insulation.
      s. C552: Specification for Cellular Glass Block and Pipe Thermal Insulation.
      t. C553: Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
      u. C592: Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
      v. C612: Specification for Mineral Fiber Block and Board Thermal Insulation.
      w. C755: Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation.
      x. C795: Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      y. C916: Standard Specification for Adhesives for Duct Thermal Insulation.
      z. C921: Practice for Determining Properties of Jacketing Materials for Thermal Insulation.

aa. C1071: Standard Specification for Thermal and Acoustical Insulation.
bb. C1104: Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
cc. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
dd. C1338: Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
ee. C1393: Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
ff. C1617-05: Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals
gg. E84: Test Method for Surface Burning Characteristics of Building Materials.
hh. E119: Test for Fire Resistance.
ii. G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
jj. G22: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
   a. 90: Energy Conservation in New Building Design.
3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
   b. 255: Test Methods, Surface Burning Characteristics of Building Materials.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method where installed in a return air plenum or in a ventilation intake or mechanical room. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

E. Corrosiveness: Passes ASTM C1617-05, Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals.

F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

G. Sustainable Project Requirements:
   1. Formaldehyde Free: Third party certified with UL Environment or Scientific Certification Systems (SCS) Validation.
   2. Biosoluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) and supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).
   3. Low Emitting Materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of GREENGUARD Certification.

1.07 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
   1. Pentabrominated diphenyl ether (CAS#32534-81-9).
   2. Octabrominated diphenyl ether (CAS#32536-52-0).
   3. Decabrominated diphenyl ether (CAS#1163-19-50).

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

1.09 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Comply with requirements in "Part 3, Table 1: Piping Services, Fluid Temperature, and Insulation Type Required" for application of insulating materials.

B. Products shall not contain asbestos, lead, mercury or mercury compounds if possible. Products shall meet UL GREENGUARD certification standards for low-emitting products.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Each insulation material has been provided a descriptive key code, such as **PI-A**, to simplify the organization and application of materials in following sub-sections.

F. Thickness of insulation is based on meeting or exceeding the minimum requirement of applicable energy code and/or maximum allowable external temperature in relation to adjacent combustible material or other equipment. Exterior surface temperature shall not exceed 140°F at maximum operating capacity except as noted below for generator applications.

G. Acceptable manufacturers include Knauf Insulation, Johns Manville, Owens-Corning, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Aeroflex, Armacell, Reflectix, Pacor or equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each product classification.

2.02 PIPE INSULATIONS (IDENTIFIED BY KEY CODE PI BELOW AND IN TABLE 1)

A. **PI-A,** Preformed Mineral Wool or Fiberglass:
   1. Materials: Mineral wool or fiberglass bonded with a thermosetting resin. Product to be validated GREENGUARD Gold for low VOC's. In addition, pipe insulation to have a validated EPD from UL Environment or Scientific Certification Systems.
   2. Applications: Insulation of piping and fittings with thickness as required by local energy code.
   3. Compliant with ASTM C335, C356, C411, C447, C547, C585, C795, C1045, C1104 E96, and E84.
   4. Compliant with ASTM C547 Type I, 850°F (454°C) or Type IV, 1000°F (538°C).
   5. Thermal conductivity (K-value): 0.24 Btu•in./(hr•ft²•ºF) or less, at 100°F (38°C).
   6. Service Temperature Range: 0°F to 850°F (-18°C to 454°C).
   7. Water Vapor Absorption, % of volume: <5% (maximum) as tested per ASTM C1104.
   8. Vapor Retarder Jacket: Factory applied ASJ or ASJ+ with SSL, white kraft paper interleaving reinforced with glass fiber scrim yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips.
   9. Water Vapor Permeance: 0.02 perms maximum.

10. Nominal density is 2.5 lbs./cu. ft., greater.
11. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
12. Manufacturers: Knauf #ECOSE Earthwool 1000°, Johns Manville #Micro-Lok or #Micro-Lok, Owens Corning, CertainTeed, Manson or equal.

B. **PI-B,** Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene:
1. Applications: Insulation of piping and fittings with thickness as required by local energy code.
2. Compliant with UL 181, ASTM C411, C518, C534, G21/C1338, G22, D1056 and E84.
3. Service Temperature Range: -297°F to 220°F (-183°C to 105°C).
4. Thermal Conductivity (K-value): 0.28 Btu•in./(hr•ft²•ºF) or less, at 75°F (24°C).
5. Water Vapor Absorption, % of volume: <0.2% (maximum) compliant with ASTM C209.
6. Nominal density is 2.5 lbs./cu. ft. or greater.
7. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
8. Seal all seams and joints with contact adhesive or factory self-seal system with lap seal tape.
9. Manufacturers: Armacell #AP Armaflex, Rubatex #K-Flex ECO, Aeroflex #Aerocel or equal.

C. **PI-E,** Rigid Preformed Hydrous Calcium Silicate:
1. Applications: High temperature insulation for piping and equipment and for placement at piping hangers and supports.
2. Compliant with ASTM C165, C302, C356, C447, C533, C665, C1338 and E84.
3. Maximum Service Temperature: 1200°F (650°C).
4. Thermal conductivity (K-value): 0.389 Btu•in./(hr•ft²•ºF) or less, at 200°F (93°C).
5. Nominal density is 14 lbs./cu. ft. or greater.
6. Compressive Strength (block): Minimum of 100 psi to produce 5% compression as tested per ASTM C165.
7. Surface Burning Characteristics: Flame Spread Index =0 and Smoke Developed Index =0 ratings as tested per ASTM E84.
8. Tie Wire: 16-gauge stainless steel with twisted ends on maximum 12” centers.
9. Product must contain corrosion inhibiting chemistry.
10. Manufacturers: Johns Manville Industrial Insulation Group #Thermo-12 Gold or equal.

2.03 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ+: White, polypropylene-coated, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
3. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

4. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
5. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.04 JACKETING MATERIALS

A. Field Applied Jackets (For Indoor Applications):
1. All longitudinal seams shall be located on bottom of pipes.
2. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
3. PVC Plastic:
   a. High-impact-resistant, UV-resistant PVC as tested per ASTM C553, C547, C665, C795, C1338, D1784, E96, C1136 and D3679.
   b. One piece molded type fitting covers and jacketing material.
   c. Adhesive: As recommended by jacket material manufacturer.
   d. Color: White.
   e. Thickness: 20 mil (0.5 mm), minimum.
   f. Service Temperature Range: 0°F to 150°F (-18°C to 66°C).
   g. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
   h. Manufacturers: Johns Manville #Zeston 2000, Proto #LoSmoke or equal by PIC Plastics, Proto Corporation, Speedline Corporation or equal.
4. Aluminum Jacket:
   a. Comply with ASTM B209/B209M.
   b. Aluminum alloy 3003, 3005, 3105 or 5005 with an H-14 temper.
   c. Thickness: 0.016” thick sheet (minimum).
   d. Finish: Smooth or stucco embossed
   e. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
   f. Longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8” or 1/2” stainless steel bands on 12” centers.
   g. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤50 ratings as tested per ASTM E84.
   h. Manufacturers: Pabco, Childers, RPR, ITW or equal.
5. Canvas Jacket:
   a. Cotton or fiberglass cloth.
   b. UL listed fabric treated with dilute fire retardant.
   c. Lagging adhesive per manufacturer.
   d. Manufacturers: GJC General, GLT Products, Foster #Mast-A-Fab, Childers #Chil-Glas No. 5 or equal.

B. Field Applied Jackets (For Outdoor Applications):
1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
2. Secure stainless steel or aluminum jackets with 3/8” or 1/2” stainless steel bands on 12” centers and at each joint.
3. PVC Jacket: Not allowed for outdoor applications.
4. Canvas Jacket: Not allowed for outdoor applications.

5. Aluminum Jacket:
   a. Comply with ASTM B209/B209M.
   b. Aluminum alloy 3003, 3005, 3105 or 5005 with an H-14 temper.
   c. Thickness: 0.016” thick sheet (minimum).
   d. Finish: Smooth, stucco embossed or corrugated surface.
   e. Color: White with surface emittance of 0.8, or greater, per ASTM C1371 for piping and equipment exposed to sunlight.
   f. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
   g. Longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8” or 1/2” stainless steel bands on 12” centers.
   h. Manufacturers: Pabco, Childers, RPR, ITW or equal.
6. Self-Adhesive Aluminum Jacket:
   a. Comply with ASTM D774, C1338, C1371, E96 and D882.
   b. Thickness: 56 mils (minimum).
   c. Multi-ply UV-resistant aluminum foil/polymer laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
   d. Color: White with surface emittance of 0.8, or greater, per ASTM C1371 for piping and equipment exposed to sunlight.
   e. Weight: 0.3 lbs./sf, minimum.
   f. Service Temperature Range: -15°F to 160°F (-26°C to 71°C).
   g. Manufacturer: Polyguard Products #Alumaguard or equal.
7. Stainless Steel Jacket:
   a. Comply with ASTM A240 and A666.
   b. Stainless steel alloy T-304 or T-316. T-316 shall be used in corrosive environments including close proximity to coast.
   c. Thickness: 0.016” thick sheet (minimum).
   d. Dull Finish: Smooth, stucco embossed or corrugated surface.
   e. Color: White with surface emittance of 0.8, or greater, per ASTM C1371 for piping and equipment exposed to sunlight.
   f. Moisture Barrier: 3 mil thick polysurlyn or 3 mil thick polyethylene.
   g. Longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner. Secure with 3/8” or 1/2” stainless steel bands on 12” centers.
   h. Manufacturers: Pabco, Childers, RPR, ITW or equal.

C. Removable Covers:
1. Provide removable covers on indoor pumps, valves, air separators, air vent fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation is required.
   a. Pre-molded insulation covers:
      1) Cold Systems: Provide PVC covers over insulated elbows, fittings and flanges.
      2) Cold Systems: Provide flexible closed cell foam or removable cloth insulating blankets for valves, pumps and strainers.
      3) Hot Systems: Provide PVC covers over insulated elbows, fittings and flanges.
      4) Hot Systems: Provide removable cloth insulating blankets on valves, pumps, and strainers.

b. Removable cloth insulating blankets:
   1) Service Operating Temperature: 0-350°F.
   2) Jacket and Liner: silicon or teflon impregnated mineral wool cloth.
   3) Liner Reinforcement: stainless steel mesh cloth.
   4) Insulation: Fiberglass matt or Pacor #Aerogel, 2” thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
   5) Fastening: 2” Nomex Velcro or 1” straps and stainless steel D-rings or 12-gage stainless steel hooks and stainless steel wire.
   6) Thread: Kevlar/stainless steel thread.
   7) Outdoor Applications: Jacket shall be UV and ozone resistant with Velcro attachment.
   8) Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, Alpha or equal.

2.05 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive:
   1. Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 1200°F (10 to 649°C).
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Manufacturers: Childers Brand #CP-97, Johns Manville #CalBond Gold, Marathon Industries #290, Foster Brand #81-27, Mon-Eco Industries #22-30, Vimasco Corporation #760 or equal.

C. Cellular-Glass Adhesive:
   1. Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200°F (minus 73 to plus 93°C).
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Manufacturers: Foster Brand #81-84 or equal.

D. Phenolic and Polyisocyanurate Adhesive:
   1. Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300°F (minus 59 to plus 149°C).
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Manufacturers: Childers Brand #CP-96, Foster Brand #81-33 or equal.

E. Flexible Elastomeric and Polyolefin Adhesive:
   1. Comply with MIL-A-24179A, Type II, Class I.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Manufacturers: Armaflex #520 Adhesive, Foster Brand #85-75, K-Flex USA #R-373, Aeroflex USA, Aeroseal, Armacell, or equal.

F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Manufacturers: Childers Brand #CP-127, Eagle Bridges - Marathon Industries #225, Foster Brand #85-60/85-70, Mon-Eco Industries, Inc.#22-25 or equal.

G. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Manufacturers: Childers Brand #CP-82, Eagle Bridges - Marathon Industries #225, Foster Brand #85-50, Mon-Eco Industries, Inc.#22-25 or equal.

H. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Manufacturers: Dow Corning Corporation #739, Dow Silicone, Johns Manville #Zeston Perma-Weld, CEEL-TITE #Solvent Welding Adhesive, P.I.C. Plastics, Inc. #Welding Adhesive, Speedline Corporation #Polyco VP Adhesive or equal.

2.06 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based for indoor use.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
   3. Vapor Safe Coating: Shall meet requirements of LEED IEQ Low-Emitting Materials. VOC 33 g/l, less water and exempt solvents.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   5. Color: White.
   6. Manufacturers: Foster Brand #30-80/30-90, Vimasco Corporation #749 or equal.

C. Vapor-Barrier Mastic: Solvent based for outdoor use.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220°F (Minus 46 to plus 104°C).
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.
   5. Manufacturers: Childers Brand #Encacel X CP-40, Eagle Bridges - Marathon Industries #570, Foster Brand #60-95/60-96 or equal.

D. Breather Mastic: Water based for indoor and outdoor use.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82°C).
   3. Solids Content: 60 percent by volume and 66 percent by weight.

4. Color: White.
5. Manufacturers: Childers Brand #CP-10/CP-11, Eagle Bridges - Marathon Industries #550, Foster Brand #46-50, Mon-Eco Industries, Inc. #55-50, Vimasco Corporation #WC-1/WC-5 or equal.

2.07 LAGGING ADHESIVES

A. Adhesives shall be compatible with insulation materials, jackets, and substrates.
1. Comply with MIL-A-3316C, Class I, Grade.
2. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to 180°F (-18 to 82°C).
5. Color: White.
6. Manufacturers: Childers Brand #CP-50 AHV2, Foster Brand #30-36, Vimasco Corporation #713/714 or equal.

2.08 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate.
a. Manufacturers: Childers Brand #CP-76, Marathon Industries#405, Foster Brand #30-45, Mon-Eco Industries, Inc.#44-05, Pittsburgh Corning Corporation #Pittseal 444 or equal.
2. Joint Sealants for Polystyrene.
a. Manufacturers: Childers Brand #CP-70, Marathon Industries #405, Foster Brand #30-45, Mon-Eco Industries, Inc.#44-05 or equal.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: -100 to 300°F (-73 to 149°C).
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Shall be compliant with requirements of LEED IEQ Low-Emitting Materials.

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturers: Childers Brand #CP-76, Eagle Bridges - Marathon Industries #405, Foster Brand #95-44, Mon-Eco Industries, Inc. #44-05 or equal.

C. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121°C).
4. Color: White.

5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Manufacturers: Childers Brand #CP-76 or equal.

2.09 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
7. Manufacturers: ABI, Ideal Tape Division #428 AWF ASJ, Avery Dennison Corporation #Fasson 0836, Compac Corporation #105, 3M Venture Tape #1540 CW Plus/1542 CW Plus/1542 CW Plus/SQ or equal.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
7. Manufacturers: ABI Tape #491 AWF FSK, Avery Dennison Corporation #Fasson 0827, Compac Corporation #110 and 111, 3M Venture Tape #1525 CW NT/1528 CW/1528 CW/SQ or equal.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
6. Manufacturers: ABI Tape #370 White PVC tape, Compac Corporation #130, Venture Tape #1506 CW NS or equal.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
6. Manufacturers: ABI Tape #488 AWF, Avery Dennison Corporation #Fasson 0800, Compac Corporation #120, 3M Venture Tape #3520 CW or equal.

2.10 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304, 0.020 inch (0.50 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing seal.Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application. (Note to Editor: Springs are used for large, 84-inch- (2130-mm-) diameter applications and on applications with rapid changes in expansion and contraction.)
3. Manufacturers: ITW Insulation Systems, Gerrard Strapping and Seals, RPR Products, Inc., Insul-Mate Strapping, Seals, and Springs or equal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   a. Manufacturers: AGM Industries #CWP-1, GEMCO #CD, Midwest Fasteners #CD, Nelson Stud Welding #TPA/TPC/TPS or equal.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
   a. Manufacturers: AGM Industries #CHP-1, GEMCO #Cupped Head Weld Pin, Midwest Fasteners #Cupped Head, Nelson Stud Welding #CHP or equal.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel coordinated with application, fully annealed, 12 gauge, 0.106-inch-(2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   d. Manufacturers: AGM Industries, Inc. #Tactoo Perforated Base Insul-Hangers, GEMCO #Perforated Base, Midwest Fasteners, Inc.#Spindle or equal.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
d. Manufacturers: GEMCO #Nylon Hangers, Midwest Fasteners, Inc.#Nylon Insulation Hangers or equal.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum, Stainless steel, fully annealed, as coordinated with application. 12 gauge, 0.106-inch - (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.
   d. Manufacturers: AGM Industries, Inc. #Tactoo Self-Adhering Insul-Hangers, GEMCO #Peel & Press, Midwest Fasteners #Self Stick or equal.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.015-inch-(0.41-mm-) thick, galvanized-steel, aluminum or stainless-steel sheet, as coordinated with application with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
   b. Manufacturers: AGM Industries #RC-150, GEMCO #R-150, Midwest Fasteners #WA-150, Nelson Stud Welding #Speed Clips or equal.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Manufacturers: GEMCO, Midwest Fasteners, Inc or equal.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
   1. Manufacturers: C & F Wire or equal.

2.11 ACOUSTICAL PIPE WRAP

A. Acoustical pipe lagging for noisy pipes. Barrier material shall meet the sound transmission loss and physical properties performance requirements as follows:
   1. Vinyl noise barrier with reinforced foil facing on one side.
   2. Service Temperature Range: -40°F to 220°F (-40°C to 104°C).
   3. Nominal density: 2 lbs./sf or greater.
   4. Surface Burning Characteristics: Flame Spread Index ≤25 and Smoke Developed Index ≤450 ratings as tested per ASTM E84. Not compliant for use in return air plenums without metal jacket.
   5. Sound transmission class: 31
   6. Sound Transmission Loss (dB) Table per ASTM E90:

dB Reduction at each Octave Band Center Frequency (Hz)						
125 hz	250 hz	500 hz	1000 hz	2000 hz	4000 hz	STC
16	22	26	32	35	40	31

7. Manufacturers: Sound Seal #B-20 LAG/QFA-9, Kinetics #KNM-100AL Series or equal.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping and ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.02 INSTALLATION

A. General:
1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Pipe fittings, valves, pipe flanges, pumps, strainers, gauge fittings, etc., shall be insulated to the same insulation thickness as adjoining piping and as required by local energy code. All support points, joints and fittings shall be insulated for continuous insulation coverage with no gaps or voids.

B. Piping Insulation:
1. Locate insulation and cover seams in least visible locations unless otherwise specified.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Provide vapor retardant jackets with self-sealing laps on insulated cold pipes conveying fluids below ambient temperature. Insulate complete system. Staples used on pipes conveying fluids below ambient temperatures (cold systems) must be covered with approved mastic.
4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self-sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
5. Provide insert between support shield and piping on piping 1-1/2” diameter and larger. Fabricate insert using hydrous calcium silicate or other heavy density insulating material suitable for temperature and required insulation thickness. Insulation inserts shall not be less than the following lengths:
a. 1-1/2" to 2-1/2" pipe size: 10" or longer.

b. 3" to 6" pipe size: 12" or longer.
c. 8" to 10" pipe size: 16" or longer.
d. 12" pipe size and larger: 22" or longer.

6. For smaller pipe sizes, less than 1-1/2” diameter, provide metal or pre-manufactured plastic insulation shield to support the insulated pipe through the support point at the hanger or saddle. Pipe shield shall be a minimum of 6” long to distribute the weight of the insulated pipe without crushing or damaging the insulation. Pipe shield shall be located outside of the metal insulation jacket where applicable.
7. Use of metal saddles is acceptable as specified in Section 230500. Fill interior voids with segments of insulation matching adjoining pipe insulation.
8. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices.
9. For insulated pipe exposed in mechanical equipment rooms or in finished spaces below seven (7) feet above finished floor, cover insulation with PVC or metal jacketing.
10. Where pumps, valves (manual and control types), strainers, etc., with insulation require periodic opening for maintenance, repair or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.
    a. Cold Systems: Provide elastomeric foam for pumps and strainers.
    b. Hot Systems: Provide removable blanket covers on valves, pumps, and strainers.
11. For exterior applications:
    a. Apply weather-resistant protective finish to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping.
    b. All lateral and longitudinal insulation joints to be sealed with low VOC, UV inhibitive adhesive.
    c. Provide weather protection jacket over insulation. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. PVC or plastic jackets are not allowed exterior to the building. Jacket seams shall be located on bottom side of horizontal piping. All lateral jacket joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal jacket joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
12. For underground installations, install per manufacturer's written instructions and recommendations.
13. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.
14. Jacket Locations for Pipe, Valve and Fittings. Provide protective insulation jackets for the following locations where not defined elsewhere in the specifications for piping systems:

Insulation Jacket Location	Jacket Material
Indoors: Concealed in Accessible Ceiling Voids.	None.
Indoors: Concealed in Inaccessible Ceiling Voids.	None.
Indoors: Concealed in Accessible Portions of Shafts or Chaseways.	None.
Indoors: Concealed in Inaccessible Portions of Shafts or Chaseways.	None.
Indoors: Mechanical Rooms.	PVC or Aluminum or Stainless Steel to seven (7) feet AFF.
Indoors: Exposed to view in normally occupied spaces such offices, conference rooms, restaurants and retail spaces.	PVC.
Indoors: Exposed to view in warehouse, storage and manufacturing spaces.	None.
Outdoors: Exposed to weather.	Aluminum or stainless steel with white coating for low emissivity.
Outdoors: Exposed in covered outdoor areas such as garages or under canopies.	Aluminum or stainless steel.
Outdoors: Located in vaults or accessible concrete trenches.	Aluminum or stainless steel.

3.03 PIPING INSULATION SCHEDULE

A. TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED.

1. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness by 1/2" (minimum) where insulated pipe is exposed to exterior ambient air. Minimum thermal resistance shall comply with building code minimum ranges and may exceed those minimum levels. Insulation thicknesses may be adjusted for equivalent insulation values for materials with superior "K" factors. Refer to "PART 2-PRODUCTS" for characteristics of each insulation material listed below.

PIPE INSULATION INDEX	
INSULATION KEY CODE	INSULATION TYPE
PI-A	Preformed Flexible Mineral Wool or Fiberglass.
PI-B	Preformed Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene.
PI-E	Rigid Preformed Hydrous Calcium Silicate.

TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED		
SERVICE	INSULATION KEY CODE	THICKNESS/REMARKS (Minimum)
Insulated pipes at pipe hangers and supports with saddles or 360° shields.	**PI-E**	Thickness as required by State Energy Code. See Table 2 below. Refer to 230500 Basic HVAC Materials and Methods for length of saddles and shields based on pipe size. Required on pipe sizes 1-1/2" and larger.
Cooling coil condensate drain piping and traps located inside spaces within the building, and above ceilings and in attics.	**PI-A or B**	Provide 1/2" (minimum) thickness insulation, all pipe sizes. Refer to Division 22.
Cooling coil condensate drain piping and traps located inside the building, in mechanical rooms located in buildings located in humid climates defined as "A-Moist" or "C-Marine" in the IECC.	**PI-A or B**	Provide 1/2" (minimum) thickness insulation, all pipe sizes. Refer to Division 22.
Cooling coil condensate drain piping and traps located outdoors.	**N/A**	Not required.
Refrigerant suction piping.	**PI-B**	Provide 3/4" (minimum) thickness insulation or increased thickness as required by State Energy Code. See Table 2 below.
Refrigerant liquid and hot-gas piping.	**PI-B**	Provide 3/4" (minimum) insulation for all warm/hot piping in close proximity to human contact and where located in enclosed ceiling, shaft or chase spaces.
Refrigerant piping for heat pump and VRF systems.	**PI-B**	Provide 3/4" (minimum) thickness insulation on all piping.

B. TABLE 2: MINIMUM PIPING INSULATION THICKNESS BASED ON FLUID TEMPERATURE AND PIPING SIZE.
   1. California

Table 2

Insulation Based on California T-24 Energy Code Table 120.3-A

Minimum Pipe Insulation Thicknesses or Greater

FLUID TEMPERATURE RANGE (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)				
			Less than 1	1 and 1-1/4	1-1/2 to 3	4 to 6	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)				
Space heating systems (steam, steam condensate and hot water) and Domestic Services Water Heating Systems							
Above 350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.31	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.22-0.28	100	1.0	1.5	1.5	1.5	1.5
Space cooling systems (chilled water, refrigerant and brine)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
40-60 residential	0.21-0.27	75	0.75 for residential		1.0	1.0	1.0
Below 40	0.20-0.27	75	1.0	1.5	1.5	1.5	1.5

3.04 ACOUSTIC PIPE WRAP

A. Acoustic pipe wrap is to be used in piping system which occur over occupied spaces for the following:
   1. Horizontal condenser water riser offsets.
   2. Pipe, valves and fittings where water velocity exceeds 8 feet per second.

END OF SECTION

SECTION 23 09 00 - BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include but not necessarily be limited to the following:
   1. Provide new direct digital Building Automation System (BAS) for the new building with all hardware, software, controller, devices, sensors, conduit, wiring, and labor as required to provide complete and operational systems.
   2. Provide Tridium front end to interface existing building BAS systems with new building BAS.

B. General Requirements
   1. The work includes designing, providing and installing a complete and fully operable building automation system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the authorities having jurisdiction. Any alternations to the quantity or location of the control panels shall be coordinated with the Electrical Contractor and General Contractor prior to bidding. Any BAS changes after bidding must be coordinated with Electrical Contractor and General Contractor at no additional cost to Owner.
   2. Submit shop drawings of the entire control system components fully coordinated with major equipment suppliers' requirements. Provide proposed programming logic sequences of control functions on each system.
   3. Installation of control components other than valves, dampers and sensing wells as required for a complete and workable system.
   4. This Contractor shall furnish, install and coordinate the interlock and control wiring as specified and/or required for a complete and workable control system.
   5. Controls dampers are specified and furnished in Section 233113 of these specifications. Provide damper actuators, wiring and conduit as required to operate all dampers as shown.
   6. Upon completion of the installation, data entry and programming, provide complete validation and adjustment of specified control system through period of testing and Owner’s acceptance. The control contractor shall perform a point-to-point check out of all newly installed points to verify point existence, proper end to end connection and correct SI units with the Owners Representative.

7. The entire program and sequence of operation with the final points list shall be verified by the Control Contractor, the Owner's Representative, and signed by both parties. A copy of the final program, sequence of operation, and points list shall be submitted to the Engineer for approval and inclusion with the operation and maintenance manuals.
8. Owner training on operation of the control system.
9. One-year warranty on workmanship and materials.
10. Interlocking of electrical systems and motors as shown on Drawings, except where specifically shown on electrical drawings.

1.03 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

C. Refer to Division 23 and the following sections for Mechanical or Electrical Provision.
1. Division 01 - Submittal Procedures
2. Division 01 - Commissioning
3. Section 23 0500: Basic HVAC Materials and Methods
4. Section 23 0593: Testing, Adjusting, and Balancing
5. Section 23 0902: Variable Frequency Drives
6. Section 23 2113: Hydronic Piping, Valves and Specialties
7. Section 23 2123: Hydronic Pumps
8. Section 23 3113: Air Distribution
9. Sections 23 7000 through 238999 equipment
10. Division 26 – Electrical Materials and Methods
11. Division 28 – Electronic Safety and Security

D. Refer to Division 26 sections for Electrical Provisions. Sources of 120-volt electrical power as indicated on electrical drawings and specifications for control system components furnished by this section. The controls contractor shall be responsible for all additional electrical distribution from these connection points to the control panels and other controls devices.

E. BAS contractor will furnish, but not install the following:
1. Air flow measuring stations: furnish to mechanical installer and coordinate per manufacturer's requirements.
2. Flow meters: furnish to mechanical installer and coordinate per manufacturer's requirements.
3. Flow switches: furnish to mechanical installer and coordinate per manufacturer's requirements.
4. Hydronic pressure and temperature sensor wells: furnish to mechanical installer and coordinate per manufacturer's requirements.
5. Control valves: furnish to mechanical installer and coordinate per manufacturer's requirements.

1.04 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
   2. ANSI/ASHRAE Standard 135-2012, BACnet.
   3. International Building Code (IBC), including local State and Local amendments.
   4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
   5. National Electrical Code (NEC).
   6. FCC Part 15, Subpart J, Class A.
   7. EMC Directive 89/336/EEC (European CE Mark).
   8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.05 DEFINITIONS

A. ASHRAE: American Society of Heating, Refrigerating, and Air-conditioning Engineers

B. BACnet: BACnet is a preferred communications protocol for building automation and control networks. It is an ASHRAE, ANSI, and ISO standard protocol. BACnet MS/TP is utilized with EIA/RS 485 hardware and BACnet/IP with Ethernet.

C. BAS: A system that optimizes the start-up and performance of HVAC equipment and alarm systems. A BAS greatly increases the interaction between the mechanical subsystems of a building, improves occupant comfort, lowers energy use, and allows off-site building control.

D. Modbus: One of industry standard communication protocols supported by NTMC. Developed by Modicon, Inc., North Andover, MA.

E. ODVA™: (Open DeviceNet Vendors Association) An international organization that supports computing network technologies based upon the Common Industrial Protocol (CIP). These include DeviceNet, EtherNet/IP, CIP Safety and CIP Sync.

F. RTD: Resistance temperature detector is a sensor whose resistance changes with temperature.

G. SCADA System (Supervisory Control And Data Acquisition): A type of industrial control system; a computer system which monitors and controls industrial, infrastructure, or facility-based processes.

H. Transducer: A device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa.

I. Transmitter: A set of equipment used to generate and transmit electromagnetic waves carrying messages or signals.

1.06 GENERAL REQUIREMENTS

A. Furnish a distributed logic BACnet-based control system including operator's workstation. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

B. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

C. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

D. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

E. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

F. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

G. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

H. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

I. Provide a comprehensive operator and technician training program as described herein.

J. Provide as-built documentation, operator's terminal software, a software key for a minimum of one additional computer (coordinate with Owner's Representative if additional keys are required), diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

K. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.07 TRIDIUM REQUIREMENTS

A. The Building Automation System (BAS) specified herein is an “integrated” system that utilizes a Tridium Niagara (N4) front end with BAS contractor’s native BACnet controllers. The BAS contractor shall furnish and install all Tridium Niagara (N4) based front end, hardware systems, and equipment to access and interface with a BACnet control system that utilizes unitary controllers to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, etc., and all air handlers, boilers, chillers, and any other listed equipment.

B. The BAS contractor shall develop, test, and commission all Tridium Niagara (N4) and GUI (Graphic User Interface) software applications for the HVAC control system. Additionally, the BAS contractor shall configure and commission the Ethernet communication network for the HVAC system.

C. Only BAS contractors that are Factory Authorized to sell and install the Niagara (N4) hardware and software are authorized to bid. The Niagara (N4) Authorized Contractor will have a minimum of three factory trained programmers. The programmers will have completed the Niagara (N4) Certification Program and work as full time employees, not sub-contractors.

D. It is the owner’s express goal to implement an open system that will allow products from various suppliers to be integrated into unified systems in order to provide flexibility for expansion, maintenance, and service of the system. The owner shall be the named license holder of all software associated with any and all incremental work on the project(s). All Niagara (N4) software licenses shall have the ‘accept.station.in=”*”; accept.station.out=”*”, accept.wb.in=”*” and ‘accept.wb.out=”*” section of the software licenses. The intent is to insure that the installed Niagara (N4) products may be completely open for integrations. The Owner shall be free to direct the modifications of the any software license, regardless of supplier. In addition, the Owner shall receive ownership of all job specific software configurations documentation, data files, and application-level software developed for the project. This shall include all custom job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use within Niagara (N4) Framework (Niagara (N4)) based controllers and/or servers and any related LAN/ WAN Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the Owner.

E. Furnish a distributed logic BACnet-based control system, compatible operator’s workstation. The operator’s workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system’s functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

F. The Web Server is a flexible network server for multiple connected Niagara controllers. The Web Supervisor is designed to harness the power of the Internet and provide efficient integration and aggregation of the information from multiple controllers. In effect, the Web Supervisor creates a single view of these multiple devices, while providing a powerful network environment with comprehensive database management, alarm management, and messaging services. In addition, the Web Supervisor provides the engineering environment used to set up and manage the systems and the graphical user interface. The software is designed to run on 64-bit Windows 8.1 Enterprise, Windows Server 2012 Standard, 2012 R2 Standard, or better. The browser interface utilizes HTML5. JAVA is not required for the system and graphics to operate.
   1. Processor: Intel Xeon CPU E5-2640 x64, or better, and is compatible with dual and quad core processors.
   2. RAM: 4 Gb of memory minimum.
   3. Hard disk: minimum 4 TB hard drive and additional space for archiving purposes.

1.08 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2012, BACnet and achieved listing under the BACnet Testing Laboratories BACnet - Advanced Workstation Software (B-AWS). This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. The Building Automation System (BAS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator’s terminal. Operator’s terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. All application controllers for every piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

E. Room sensors shall be provided with digital readout that allow the user to view room temperature, CO2 or relative humidity, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

1.09 QUALITY ASSURANCE

A. The BAS shall be designed, installed, commissioned, and serviced by contractor authorized and trained personnel. System provider shall have an in-place support facility within two (2) hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

B. The manufacturer and installer shall have a minimum of 5 years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A list of successful past projects of similar type, size and complexity shall be submitted. In addition, a reference list of names, addresses and telephone numbers of the design Engineer and the Owner's Representative for each installation shall be provided. The references may be contacted and questioned about the timely delivery, installation, operation and service received for each installation.

C. The contractor shall provide experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

D. The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

E. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

F. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

H. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 100 miles of project site.

I. Control components shall be products of the same manufacturer only, unless indicated otherwise and approved by Owner's Representative. Example – all valves shall by one manufacturer and all temperature sensors shall be by one manufacturer.

1.10 SUBMITTALS

A. Drawings

1. The system supplier shall submit point-to-point engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in a standard size of 11” x 17” (ANSI B), or larger.
3. Eight complete sets (copies) of submittal drawings shall be provided.
4. Drawings shall be available on portable memory device, DVD or CD disk media.

B. System Documentation
1. Include the following in submittal package:
   a. System configuration diagrams in simplified block format.
   b. All input/output object listings and an alarm point summary listing.
   c. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
   d. Complete bill of materials, valve schedule with Cv, valve pressure drop at design flow, and damper schedule.
   e. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
   f. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
   g. For all system elements—operator’s workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2012.
   h. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
   i. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management
1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.11 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

C. Warrant work as follows:
1. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Warrant all actuators for a period of five (5) years.
3. Respond during normal business hours within 24 hours of Owner’s warranty service request.
4. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

5. If Owner's Representative determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Owner's Representative will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
6. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
7. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable BAS Manufacturers include:
   1. Johnson Controls
   2. Distech

2.02 OPERATOR'S WORKSTATION

A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 simultaneous clients.

B. Primary Operator Workstation Hardware
   1. All workstations shall be general purpose microcomputer systems serving as an operator station in a cooperative processing server/client relationship with other connected work stations. The workstation shall consist of a high-speed central processing unit (CPU) with data storage facilities, high-resolution, 24", LCD monitor. Components shall be capable of operating in environments of 60°F to 105°F and relative humidity of 30% to 90%.
   2. CPU: Intel Xeon CPU E5-2640 x64, or better, and compatible with dual & quad core processors.
   3. Memory: 8 GB (minimum).
   4. Hard Drive: 1 TB (minimum) for the BAS operating software.
   5. Hard Drive: 4 TB (minimum) to be used for trend log archiving of annual data.
   6. Display: Video card and monitor capable of displaying 1920x1080 pixel resolution or better.
   7. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector, or greater).
   8. Keyboard: The keyboards shall be the enhanced with 101 keys and quiet.

C. Displays

1. In general, the operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment.
2. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label pushbuttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
3. The BAS displays shall have the ability to link to content outside of the BAS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a Web browser resolving to a specified Web address.
4. The BAS system shall have the ability to run multiple, concurrent displays windows showing continuously updated data.

D. Password Protection
1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.
2. Each operator's terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be capable of accepting 8 characters or more, User Name shall be 0–29 characters, and Passwords must accept a minimum of 4 characters and be capable of accepting 8 characters or more.
3. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.
4. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

E. Operator Activity Log
1. Operator Activity Log that tracks all operator changes and activities shall be included with system. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity log display.
2. Log shall be gathered and archived to hard drive on operator's workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

F. Scheduling
1. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
4. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

G. Alarm Indication and Handling.
1. Operator's workstation shall provide audible, visual, printed, email or test means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.
3. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

H. Trendlog Information
1. System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to view all trended records, both stored and archived. All trend log records shall be displayed in standard engineering units. Annual trend log data shall be archived by year for future analysis.
2. Software that is capable of graphing the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trend log shall support a custom scale setting for the graph view that is to be stored continuously.

3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
4. System shall be capable of using Microsoft SQL as the system database.

I. Energy Log Information
1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

J. Demand Limiting
1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.
3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

K. Tenant Activity
1. System shall include program that monitors after-hours overrides by tenants, logs that data, and generates a bill based on usage and rate charged for each tenant space. Tenant Activity program shall be able to assign multiple zones, from a list of every zone connected to system, to a particular tenant. Every zone is monitored for after-hour override usage and that data logged in server.

Operator may then generate a bill based on the usage for each tenant and the rate charged for any overtime use.

2. Configuration shall include entry of the following information for use in logging and billing:
   a. Tenant's contact name and address.
   b. One or multiple tenant zones that make up a total tenant space, including a separate billing rate for each separate zone.
   c. Minimum and maximum values an event duration and event limit.
   d. Property management information.
   e. Overall billing rate.
   f. Seasonal adjustments or surcharge to billing rate.
   g. Billing notification type such including, but not limited to printer, file and email.
   h. Billing form template.
   i. Logging shall include recording the following information for each and every tenant event.
   j. Zone description.
   k. Time the event begins.
   l. Total override time.
   m. Limits shall be applied to override time.
3. A tenant bill shall be generated for a specific period using all the entered configuration data and the logged data. User with appropriate security level shall be able to view and override billing information. User shall be able to select a billing period to view and be able to delete events from billing and edit a selected tenant activity event's override time.

L. Reports
1. System server shall be capable of periodically producing reports of trend logs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.
2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

M. Configuration/Setup
1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

N. Field Engineering Tools
1. Operator's workstation software shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.

2. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
3. System shall automatically notify the user when a device that is not in the database is added to the network.
4. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.
5. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

O. Workstation Hardware
1. Workstation/server computer minimum requirements
a. Enterprise Server (supports heavy trending and/or alarm handling at very large sites using SQL Server)
b. 64-bit Windows 8.1 Enterprise, Windows Server 2012 Standard, 2012 R2 Standard, or better,
c. Browser/client requirements: Most current versions of the following: Internet Explorer, Firefox, Chrome, Safari (Mac OS X).

P. Software
1. At the conclusion of project, contractor shall provide to the Owner's Representative a portable memory device or DVD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the Owner to completely restore the system in the case of a computer malfunction.

2.03 WEB INTERFACE

A. General
1. BAS supplier shall provide Web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard Web browser. Web browser shall tie into the network through Owner-supplied Ethernet network connection. Web page host may be a separate device that resides on the BAS BACnet network, but is not the BAS server for the control system. BAS server may be a separate computer from the Web page host device. The Web page software shall not require a per-user licensing fee or annual fees. The Web page host must be able to support simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology
1. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the webpage host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications

1. Web page host shall support Ethernet network connections. A network connection shall be used to gather real-time data from all the BACnet devices that form the BAS. This network shall communicate using BACnet, allowing the Web page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
2. An Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web page host. The Web page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive Web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
3. The Web page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.

D. Display of Data
1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered using the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment
1. Web access shall allow user to view and edit all schedules in the system. This includes three types of schedules: standard, holiday and event. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
2. Display of all three schedule types must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information
1. User shall use standard browser technology to view all trendlogs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. User shall also be able to download data through the Web interface to local computer. Data shall be in CSV format.

G. Alarm Handling
1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

H. Web Page Generation
1. Web pages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access Web page host through the network and shall initiate a Web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access using any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

I. Password Security and Activity Log
1. Access through Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log on once the browser makes connection to Web page host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a browser or through the BAS workstation.

J. BACnet Communication
1. Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.04 BUILDING NETWORK CONTROLLER

A. Building Network Controller
1. BACnet Conformance
a. Building Network Controller shall be approved by the BACnet Testing Laboratories as meeting the BACnet Building Controller requirements.

B. Building network controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.
1. Logging Capabilities
a. Logs shall be supported in the building network controller. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

b. Logs may be viewed both on-site or off-site using WAN or remote communication.
c. Building network controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

2. Alarm Generation
   a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
   b. Each alarm may be dialed out as noted elsewhere.
   c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
   d. Controller must be store alarms as BACnet event enrollment objects, with system destination and actions individually configurable.
3. Demand Limiting
   a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
   b. Load shedding programs in building controller modules shall operate as coordinated with local utility.
4. Tenant Activity Logging
   a. Tenant activity logging shall be supported by building network controller module.

C. Ethernet – MS/TP Module
1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
2. All communication with operator's workstation and all application controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.
   a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.
   b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

D. MS/TP Module
1. MS/TP module shall support every listed function in this specification and the following.
2. Building controller MS/TP module communications shall be though BACnet MS/TP LAN to all advanced application and application-specific controllers. MS/TP module shall also route messages to Ethernet – MS/TP module for communication over WAN.
   a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
   b. Configuration shall be through RS-232 connection.

E. Power Supply Module
1. Input for power shall accept between 17–30VAC, 47–65Hz.

2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

F. Modbus Module
1. Modbus Module shall support every function as listed in this specification.
2. Building Controller Modbus module communications shall be via one of three types of ports: EIA-485, EIA-422 or RS-232 connection. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
   a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
   b. EIA-422 and EIA-232 connection shall support one connection of Modbus unit.
   c. EIA-485 connection shall support connection of up to 247 Modbus units.
   d. Configuration shall be via RS-232 connection.
3. BACnet Translation
   a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
   b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.05 TRIDIUM NETWORK INTEGRATION

A. The Building Automation System (BAS) specified herein is an “integrated” system that utilizes a Tridium Niagara (N4) front end with BAS contractor’s native BACnet controllers. The BAS contractor shall furnish and install all Tridium Niagara (N4) based front end, hardware systems, and equipment to access and interface with a BACnet control system that utilizes unitary controllers to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, etc., and all air handlers, boilers, chillers, and any other listed equipment.

B. The BAS contractor shall develop, test, and commission all Tridium Niagara (N4) and GUI (Graphic User Interface) software applications for the HVAC control system. Additionally, the BAS contractor shall configure and commission the Ethernet communication network for the HVAC system.

C. Only BAS contractors that are Factory Authorized to sell and install the Niagara (N4) hardware and software are authorized to bid. The Niagara (N4) Authorized Contractor will have a minimum of three factory trained programmers. The programmers will have completed the Niagara (N4) Certification Program and work as full time employees, not sub-contractors.

D. It is the owner's express goal to implement an open system that will allow products from various suppliers to be integrated into unified systems in order to provide flexibility for expansion, maintenance, and service of the system. The owner shall be the named license holder of all software associated with any and all incremental work on the project(s). All Niagara (N4) software licenses shall have the 'accept.station.in="*"; accept.station.out="*", accept.wb.in="*" and 'accept.wb.out="*" section of the software licenses. The intent is to insure that the installed Niagara (N4) products may be completely open for integrations. The Owner shall be free to direct the modifications of the any software license, regardless of supplier. In addition, the Owner shall receive ownership of all job specific software configurations documentation, data files, and application-level software developed for the project. This shall include all custom job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use within Niagara (N4) Framework (Niagara (N4)) based controllers and/or servers and any related LAN/ WAN Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the Owner.

E. Furnish a distributed logic BACnet-based control system, compatible operator's workstation. The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

F. The Web Server is a flexible network server for multiple connected Niagara controllers. The Web Supervisor is designed to harness the power of the Internet and provide efficient integration and aggregation of the information from multiple controllers. In effect, the Web Supervisor creates a single view of these multiple devices, while providing a powerful network environment with comprehensive database management, alarm management, and messaging services. In addition, the Web Supervisor provides the engineering environment used to set up and manage the systems and the graphical user interface. The software is designed to run on 64-bit Windows 8.1 Enterprise, Windows Server 2012 Standard, 2012 R2 Standard, or better. The browser interface utilizes HTML5. JAVA is not required for the system and graphics to operate. The workstation shall include the following minimal features:
   1. Processor: Intel Xeon CPU E5-2640 x64, or better, and is compatible with dual and quad core processors.
   2. RAM: 4 Gb of memory minimum.
   3. Hard disk: minimum 4 TB hard drive and additional space for archiving purposes.

G. Java Application Control Engine JACE (8000)
   1. The Tridium JACE Controllers shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the JACE. It shall be capable of executing application control programs to provide:
      a. Calendar functions
      b. Scheduling
      c. Trending

d. Alarm monitoring and routing
e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
f. Integration of LonWorks controller data and BACnet controller data
g. Network Management functions for all LonWorks and BACnet based devices

2. The JACE (8000) must provide the following hardware features as a minimum:
   a. Two Ethernet Port -10/100 Mbps
   b. Two Isolated RS-485 and, if needed, RS -232 ports
   c. One LonWorks Interface Port - 78KB FTT-10A with Weidmuller connector.
   d. Two BACnet MS/TP interface Ports
   e. Power supply 120 VAC
   f. Battery Backup
   g. Real-time clock
   h. Processor: TI AM3352, 1GHz, or greater
   i. 1 GB Ram, or greater
   j. 4 GB flash memory.
   k. 2 GB user storage
   l. USB flash drive
   m. Wi-Fi (Client or WAP)
   n. Operating temperature: -20°C to 60°C
3. The JACE shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the Tridium JACE shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
4. The JACE shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 64 simultaneous users.
5. Event Alarm Notification and actions
   a. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   b. The JACE shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
   c. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
   d. Provide timed (schedule) routing of alarms by class, object, group, or node.
   e. Provide alarm generation from binary object "runtime" and log event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
   f. Control equipment and network failures shall be treated as alarms and annunciated.
   g. Graphic with flashing alarm object(s)
   h. The following shall be recorded by the Tridium JACE for each alarm (at a minimum):
   i. Time and date
   j. Location (building, floor, zone, office number, etc.)
   k. Equipment (air handler #, accessway, etc.)
   l. Acknowledge time, date, and user who issued acknowledgement.
   m. Number of occurrences since last acknowledgement.

n. Alarm actions may be initiated by user defined programmable objects created for that purpose.
o. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
p. A log of all alarms shall be maintained by the JACE and/or a server (if configured in the system) and shall be available for review by the user.
q. Provide a "query" feature to allow review of specific alarms by user defined parameters.
r. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
s. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

6. Data Collection and Storage
   a. The JACE shall have the ability to collect data for any property of any object and store this data for future use.
   b. The data collection shall be performed by log objects, resident in the Tridium JACE that shall have, at a minimum, the following configurable properties:
      1) Designating the log as interval or deviation.
      2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
      3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
      4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
      5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
7. All log data shall be stored in a relational database in the Tridium JACE and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
8. All log data, when accessed from a server, shall be capable of being manipulated using standard SOL statements.
9. All log data shall be available to the user in the following data formats:
   a. HTML
   b. XML
   c. Plain Text
   d. Comma or tab separated values
10. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SOL Server, Oracle Si or Expressa, Hyperion Solutions™ SOL Server.
11. The Tridium JACE shall have the ability to archive it's log data either locally (to itself), or remotely to a server or other Tridium JACE on the network. Provide the ability to configure the following archiving properties, at a minimum:
    a. Archive on time of day
    b. Archive on user-defined number of data stores in the log (buffer size)
    c. Archive when log has reached its user-defined capacity of data stores
    d. Provide ability to clear logs once archived

12. Audit Log
    a. Provide and maintain an Audit Log that tracks all activities performed on the Tridium JACE. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached the user-defined buffer size. Provide the ability to archive the log locally (to the Tridium JACE), to another Tridium JACE on the network, or to a server. For each log entry, provide the following data:
        1) Time and date
        2) User ID
        3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
13. Database Backup and Storage
    a. The Tridium JACE shall have the ability to automatically backup its database. The database shall be backed up based on a user defined time interval.
    b. Copies of the current database and, at the most recently saved database shall be stored in the Tridium JACE. An onboard micro SD card contains a real-time back up of the system software, database, graphics, license and ability to be relocated to a replacement controller in the event the original controller fails.
    c. The Tridium JACE database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
14. A JACE with I/O boards shall not be used for the control of any equipment such as fan coil units, boilers, pumps, etc. A single Unitary or Programmable controller shall manage the control functions for a specific mechanical system.

H. Ethernet – MS/TP Module
1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
2. All communication with operator's workstation and all application controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.
    a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.
    b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

I. MS/TP Module
1. MS/TP module shall support every listed function in this specification and the following.
2. Building controller MS/TP module communications shall be though BACnet MS/TP LAN to all advanced application and application-specific controllers. MS/TP module shall also route messages to Ethernet – MS/TP module for communication over WAN.
    a. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
    b. Configuration shall be through RS-232 connection.

J. Wireless Module
1. Integrated IEEE 802.11 a/b/g/n

2. The wireless function comes from the factory disabled and can be turned on or off from a selector switch and can also be turned off through software. It should be turned off when wireless is not being used. Both Client mode and Access Point mode are supported, but cannot be run simultaneously. Broadcasting of the SSID can be turned off. For those using wireless please read the JACE 8000 WiFi document for proper configuration. It supports only WPA-PSK & WPA2-SPK security protocols. It has a single dual band antenna supporting 2.4 Ghz channels 1-11 & 5.8Ghz channels 36, 40, 44, 48, 149, 153, 157, 161, & 165.
3. Several wireless protocols can be used including: WiFi, Zigbee, Z Wave, Enocean, 3G, 4G LTE.

K. Power Supply:
1. Provide UPS for power supply-backup controller.

L. Modbus Module
1. Modbus Module shall support every function as listed in this specification
2. Building Controller Modbus module communications shall be via one of three types of ports: EIA-485, EIA-422 or RS-232 connection. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
   a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
   b. EIA-422 and EIA-232 connection shall support one connection of Modbus unit.
   c. EIA-485 connection shall support connection of up to 247 Modbus units.
   d. Configuration shall be via RS-232 connection.
3. BACnet Translation
   a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
   b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.06 APPLICATION CONTROLLERS – GENERAL

A. All application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

B. All program sequences shall be stored on board controller in memory. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller ten(10) times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

C. Provide all application controllers with a minimum of 10% spare points for analog input, analog output, digital input and digital output signals.

2.07 APPLICATION CONTROLLERS –AIR HANDLER

A. Provide one or more native BACnet application controllers to adequately cover all objects listed in object list. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

C. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

D. Schedules
   1. The controller shall support a minimum of three (3) BACnet Schedule Objects and have a real-time clock on board with battery backup to maintain time through a power loss.

E. Logging Capabilities
   1. Controller shall support a minimum of 50 trend logs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
   2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

F. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

G. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.08 APPLICATION CONTROLLER – UNITARY MECHANICAL EQUIPMENT

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

2.09 APPLICATION CONTROLLER – VAV BOX SINGLE DUCT

A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

C. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.

2.10 AUXILIARY CONTROL DEVICES

A. Temperature Sensors (TS)
1. Duct air temperature (duct mounted, indoor location)
a. Thermistor type with 1/4" stainless steel probe and junction box. 10K ohm, type II, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TF Series, Dwyer Instruments #TE-DFG Series, Kele (Minco) #TT Series, or equal.

2. Duct air temperature (duct mounted, outdoor location)
   a. Thermistor type with 1/4" stainless steel probe and weather-tight junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend 25% (minimum) to 50% (maximum) into the width of duct. Manufacturer: Veris #TG Series, Dwyer Instruments #TE-DFW Series, Kele (Minco) #TT Series, or equal.
3. Outside air temperature (wall mounted location)
   a. Thermistor type with stainless steel or platinum probe and weather-proof aluminum junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe encased in durable radiation shield with radiation solar shield. Manufacturer: Veris #TO Series, Dwyer Instruments #TE Series, or equal.
4. Pipe or tank fluid temperature (immersion probe)
   a. Immersion probe type temperature sensor encased in a corrosion-resistant stainless steel thermowell. Thermistor type with metallic housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Manufacturer: Veris #TIG Series, Dwyer Instruments #TE Series, or equal.
5. Temperature averaging (coil mounting)
   a. Thermistor type with bendable copper tubing element water-resistant junction box. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA. Probe length as required to extend across coil face at least twice to cover two corners and one midpoint. Mounting of tubing shall utilize Veris #AA64 mounting clips, or equal. Manufacturer: Veris #TA Series, Kele #ACI Series, or equal.

B. Intelligent Room Temperature Sensor (TS) with LCD Readout
1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint, and activate terminal unit for override use-all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
2. The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
3. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Humidity Sensors
   1. Indoor space humidity (wall mounted inside):
      a. 1% accuracy thin film capacitive replaceable sensor element, LED display. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series or equal.
   2. Outside air humidity (wall mounted outdoors):
      a. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP-W Series, or equal.
   3. Duct air humidity (duct mounted indoor application):
      a. Humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP-W Series, or equal.
   4. Indoor space humidity with temperature (wall mounted inside):
      a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, LED display, push button override and setpoint slider. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HW Series, Dwyer Instruments #RHP-W Series, Vaisala #HMW Series, or equal.
   5. Outside air humidity with temperature (wall mounted outside):
      a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HO Series, Dwyer Instruments #RHP Series, Vaisala #HMS Series, or equal.
   6. Duct air humidity and temperature (duct mounted indoor application):
      a. Combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
      b. Manufacturers: Veris #HD Series, Dwyer Instruments #RHP Series, Vaisala, #HMT Series, or equal.
   7. Duct high limit humidity switch (duct mounted indoor application):
      a. Single-stage duct hygrostat with insertion probe to monitor humidity level with NO and NC contacts. Adjustable relative humidity setpoint range of 35 to 100% RH. SPDT 250 Vac/ 15 amp.
      b. Manufacturers: Honeywell #H6045A1002, or equal.

D. Dew Point Sensor (Wall Mounted Indoors):
   1. Dew point transmitter with non-dispersive dual beam infrared sensor in high impact ABS plastic enclosure. Measurement range from 0°F to 80°F (-18°C to 26°C) dew point with altitude correction. 24 VAC input with 0-10 VDC or 4 to 20 mA output as required by controller interface. Accuracy +/- 3.6°F (2°C).
   2. Manufacturers: GE (Telaire) #Vaporstat 9002 or equal.

E. Dew Point Sensor (Pipe Strap Mounted Indoors):
   1. Early-warning dew point switch to monitor chilled water pipes. Strap on mounting, status light, NO and NC alarm terminals, 24 VAC/0.3 VA.
   2. Manufacturers: Honeywell #HSS-DPS or equal.

F. CO2 Sensors
   1. Indoor space measurement (wall mounted):
      a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
      b. Manufacturers: Veris #CWE Series, Dwyer #CDT Series, or equal.
   2. Outdoor air measurement (indoor duct mounted location):
      a. Non-dispersive infrared sensor in high impact white ABS plastic enclosure. Input power 20 to 30 VDC/24 AC, 100 mA. Analog output 4-20 mA. Operating range 32°F to 122°F (0°C to 50°C). Measurement range of 0-2000 ppm with accuracy of +/- 30 ppm.
      b. Manufacturers: Veris #CDE Series, Dwyer #CDT Series, or equal.

G. CO2, Humidity, Temperature Combined Sensor (Indoor Wall and Duct Mounted)
   1. High impact white ABS plastic enclosure with digital LCD display and adjustable setpoints.
   2. Input power 20 to 30 VDC/24 AC, 100 mA.
   3. Analog output 4-20 mA.
   4. Operating range 32°F to 122°F (0°C to 50°C).
   5. CO2 Sensor: Non-dispersive infrared sensor in. Measurement range of 0-5000 ppm with accuracy of +/- 30 ppm.
   6. Humidity Sensor: Digitally profiled thin-film capacitive, plus or minus 2% RH. 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing. 10K ohm, Type 2, or as required for controller interface. Two-wire, loop powered 4-20 mA.
   7. Temperature Sensor: Thermistor. 2% accuracy thin film capacitive replaceable sensor element.
   8. Manufacturers: Veris #CWLP Series or equal.

H. Leak Detector
   1. Water leak detector connected to BAS to alarm on detecting the presence of water in the following locations:
      a. Secondary condensate drip pan below air conditioning air handling units and fan coils located above spaces with electrical and/or electronic equipment.
      b. Below raised access floors with one sensor per 5,000 square feet (maximum) where water pipes are located below access floor. Or, one sensor per 10,000 square feet (maximum) where no water pipes are located below access floor.
      c. On the floor adjacent to sump pump(s).
      d. On the floor of mechanical rooms adjacent to electrical equipment and/or data/electronics equipment rooms.
   2. Features:
      a. Mounting: Base mounted.
      b. Service: water of conductive fluids.
      c. Sensing gap: Minimum 1/8” (3 mm) to maximum 1/4” (6 mm).
      d. Switch type: DPDT relay.

e. External power: 1 A @ 24 VAC/DC.
f. Audible alarm: 85 dB @ 1’ distance (0.3 m).
g. Visual indicators:
h. Green to indicate power is supplied.
i. Red to indicate water is detected.
j. Temperature limits: 32 to 122°F (0 to 50°C).
k. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
l. Attached with 1/16” thick double sided adhesive urethane foam tape.

3. Manufacturers: Dwyer #WD3-LP-D2-A, Kele, Veris or equal.

I. Condensate Sensor (Pipe):
1. Solid state condensate detector for locating condensate on chilled water piping. Sensing of water shall provide a signal to the BAS system for control sequence adjustment to raise chilled water temperature.
2. Features:
a. Service: mounted on metallic pipe from 1/2” to 3” in diameter.
b. Sensing: 80% to 90% RH (adjustable) surface moisture.
c. Switch type: SPST open/close.
d. External power: 40 mA at 24 VAC or 20 mA at 12 to 30 VDC.
e. Temperature limits: 149°F (65°C).
f. Flammability: plenum rated electrical cable with length as required and UL-94 compliant housing.
g. Mounting bracket with stainless steel worm gear clamp for attachment.
3. Manufacturers: Consense #CG-ICM-P or equal.

J. Differential Pressure Transmitters:
1. Duct Static Pressure Transmitter:
a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero, LCD display.
b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series, or equal.
2. Building Static Pressure Transmitter:
a. Differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero. Provide with AA05 ceiling mount static pressure pick up, LCD display.
b. Manufacturers: Veris #PX Series, Dwyer Instruments #MS2, Kele #DPA Series, or equal.
3. Water differential pressure transmitter:
a. Differential pressure transmitter, wet/wet, switch selectable pressure ranges, jumper selectable port swap, LCD display and NEMA 4 enclosure.
b. Manufacturers: Veris #PW Series, Dwyer Instruments #MS2, or equal.

K. Differential Pressure Switches:
1. Filter differential pressure switch for status:
a. Adjustable differential pressure switch, dual scale adjustable knob, silicone diaphragm, single-pole double-throw type, 1/4" tubing diameter, setting range from 0.08 in. w.c. (20 Pa) up to 20 in. w.c. (5000 Pa), and NEMA-3 enclosure.
b. Manufacturers: Dwyer #ADPS Series or equal.
2. Duct static manual reset high pressure safety switch for supply fan shut down:

a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 3.0 to 11.75 in. w.c.
b. Manufacturers: Dwyer #1900-10-MR Series or equal.

3. Duct static manual reset high pressure safety switch for return fan shut down:
   a. Adjustable trip and manual reset, single-pole double-throw, 120-480 VAC. Maximum operating range of -30°F to 180°F (-34°C to 82.2°C) and humidity limit of 80% RH non-condensing. Provide weatherproof housing where mounted outdoors. Adjustable setpoint between 1.40 to 5.5 in. w.c.
   b. Manufacturers: Dwyer #1900-5-MR Series or equal.

L. Air Filter Differential Pressure Gauges: (where not supplied by air handling equipment manufacturer):
1. Dial type, diaphragm-actuated with external zero adjustment and 3-7/8-inch diameter dial.
2. With two (2) static pressure tips, 2-way valves, tubing and mounting plate (and adjustable signal flag).
3. Range as recommended by filter manufacturer.
4. One gauge per filter bank for direct field verification independent of BAS monitoring.
5. Manufacturers: Dwyer 2000 Series Magnehelic or equal.

M. Current Sensors
1. Current sensing switch for constant speed fans and pumps to detect belt loss, coupling shear and mechanical failure:
   a. Current switch with split core, adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #HX08 Series or equal.
2. Current sensing switch for VFD controlling multiple fans and pumps:
   a. VFD current switch split core, self-learning adjustable trip, pilot light, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #H614 or equal.
3. Current sensing switch with fixed trip point for monitoring constant speed direct-drive fans, recirculating pumps or other fixed loads:
   a. Current switch with split core, fixed trip, self-gripping split core housing and mounting bracket.
   b. Manufacturers: Veris #HX00 Series or equal.
4. Current sensing transmitter for load trending with proportional 4 to 20 mA output signal:
   a. Current sensing transmitter with self-gripping split core, preset slide switches, and removable mounting bracket.
   b. Manufacturers: Veris #H921 or equal.
5. Current sensing transmitter with relay for fan start/stop control and status monitoring of motors:
   a. Current sensing transmitter with integral relay, slide switches, self-gripping split core, and removable mounting bracket.
   b. Manufacturers: Veris #H931 or equal.

N. Flow Meters – Liquid:
   1. Single turbine insertion flow meter:
      a. 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet. Provide with D-100 totalizing display module with BACnet interface.
      b. Manufacturers: Onicon #F-1100 or #F-3000, Badger Meter #Impeller SDI Series or equal.
   2. Electromagnetic inline flow meter for high accuracy flow measurement of clean fluid in a closed loop:
      a. Accuracy: +/- 0.25% with bidirectional flow capability. Maintain minimum of three (3X) straight pipe diameters upstream and two (2X) pipe diameters downstream when installed greater than seven (7X) pipe diameters downstream of a pump.
      b. Electrodes: Two electrodes for flow measurement, one electrode for empty pipe detection, and one electrode for grounding as required by piping system. Constructed of Hastelloy C22, 316 stainless steel, gold, platinum or tantalum.
      c. Pipe spool: 316 stainless steel.
      d. Flanges: ANSI B16.5 carbon steel, 304 or 316 stainless steel.
      e. Housing: NEMA 4X weather tight aluminum enclosure, or carbon steel or stainless steel. Powder coated.
      f. Power: 120 VAC or 24 VDC.
      g. Connections: Four programmable digital outputs (minimum), one analog programmable and scalable output, and one digital input.
      h. Totalizing display: Backlit with minimum four rows of text with BACnet interface.
      i. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
      j. Fluid temperature to maximum of 212°F (100°C).
      k. Manufacturers: Badger Meter #ModMAG M2000, Onicon #FT-3000 or equal.
   3. Ultrasonic clamp-on flow meter (for metal piping installation only):
      a. Accuracy: +/- 1% with bidirectional flow capability. Maintain minimum of ten (10X) straight pipe diameters upstream and five (5X) pipe diameters downstream when installed greater than 24 pipe diameters downstream of a pump, header or valve.
      b. Transducers: Two ultrasonic transducers function as both transmitters and receivers. Volumetric flow measurement is made by measuring the difference time between two digitally synthesized contra propagating acoustic waves traveling between the two ultrasonic transducers positioned lineally, a known distance apart, on the outside of a closed pipe.
      c. Housing: NEMA 4 or 4X weather tight aluminum enclosure.
      d. Transducer housing: PVC, CPVC, PTFE or PBT glass filled as required by fluid operating temperature.
      e. Power: 120 VAC or 24 VDC.
      f. Connections: Two programmable digital outputs (minimum), one digital input, and one 4-20 mA output.
      g. Totalizing display: Backlit with minimum four rows of text with BACnet interface.
      h. Ambient operating temperature range: -4°F to 140°F (-20°C to 60°C).
      i. Fluid temperature to maximum of 212°F (100°C).

j. Flow meter may also be used with energy meter.
k. Manufacturers: Badger #Dynasonics TFX-5000, Siemens #Sitrans FS230 or equal.

O. Flow Meters - Natural Gas:
1. Thermal mass flow meter, in-line or flanged. Provide with totalizing display module with BACnet interface.
2. Manufacturers: Onicon #F-5100 Series, Badger Meter #VN-2000 or equal.

P. Flow Meters – Steam:
1. Insertion type Vortex flow meter.
2. Accuracy: +/- 1%. Maintain minimum of ten (10X) straight pipe diameters upstream and five (5X) pipe diameters downstream when installed greater than 30 pipe diameters downstream of a header or valve.
3. Sensor: Stainless steel with dual piezo vortex sensors.
4. Display: 2x16 character minimum.
5. Power: 24 VDC.
6. Connections: One digital output and one 4-20 mA output.
7. Ambient operating temperature range: 32°F to 140°F (0°C to 60°C).
8. Steam temperature to maximum of 400°F (204°C).
9. Flow meter may also be used with energy meter.
10. Manufacturers: Badger #Vortex VN2000 or equal.

Q. BTU Meters:
1. BTU meter with BACnet interface with matched temperature sensors and thermo-wells, NEMA 4X wall mount enclosure, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1” full port bronze ball valve, close nipple, and branch outlet.
2. Manufacturers: Onicon #System-10-BAC and provide with Onicon #F-1100 single turbine insertion flow meter, or Onicon #F-3500 electromagnetic flow meter, or equal by E-Mon D-Mon or Badger.

R. Airflow Measuring Arrays
1. Provide one thermal dispersion airflow/temperature measurement device (ATMD) at each location indicated on the plans, schedules and/or control schematics.
2. Each ATMD shall consist of one to four sensor probes and a single, remote transmitter. Each sensor probe shall consist of one to eight independent sensor nodes in a gold anodized, aluminum 6063 alloy tube with 304 stainless steel mounting brackets.
3. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. Chip thermistors of any type or packaging are not acceptable.
4. The velocity-weighted average temperature output performance of the ATMD is preferred to that of the specified temperature measuring device (TMD), when the location of the ATMD and TMD are effectively the same.
5. Outside Air Measurement:
a. Provide a minimum outside airflow measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow. On outdoor mounted air handling units, outside airflow measurement station is to be factory mounted on the intake side of the outside air intake (upstream of the damper).

6. Sensor Performance:
   a. Fan Installation:
      1) Installed airflow accuracy: +/- 3% to 10% of reading with +/- 0.25% repeatability.
      2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15□F temperature accuracy.
   b. Outside Air/duct Installation:
      1) Installed airflow accuracy: +/- 2% of reading with +/- 0.25% repeatability.
      2) Sensor probe performance: +/- 2% of reading, 0-5000 fpm, +/- 0.15□F temperature accuracy.
7. Transmitter:
   a. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system to be user selectable in either 4-20 mA or 0-10VDC. Coordinate signal output with controls installer.
   b. Transmitter to include an analog airflow gauge to provide direct analog readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
   c. Device to provide switch selectable Modbus or Johnson N2 outputs.
   d. Device to be UL listed.
   e. The transmitter shall be powered by 24 VAC, shall include over-voltage and over-current protection, and shall include watchdog circuitry to ensure continuous operation following power failures and/or brown- outs.
   f. The transmitter shall determine the airflow rate and temperature of each sensing node prior to averaging.
   g. The transmitter shall include self-diagnostics and other features to ensure reliability and continued operation despite a limited failure. The transmitter shall automatically detect sensor damage and correctly calculate the average using the remaining functional sensor nodes, while reporting a system fault over the network and by local visual indication.
   h. All integrated circuits shall be industrial rated for operation down to -40°F (-40°C).
   i. The environmental operating temperature limits for the transmitter shall be -20°F to 120°F (-29°C to 49°C).
   j. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.
   k. The Sensors shall be calibrated to NIST traceable standards.
8. Manufacturers: Ebtron, Paragon Controls, Dynasonics, or equal.

S. LED Pilot Lights
1. Provide wall mounted pilot lights to indicate when operable windows may be opened or closed based on outdoor weather conditions as determined by BAS. Mount adjacent to main access door serving space with operable windows or adjacent to light switch, as shown on Architectural or Mechanical drawings. Coordinate final placement of pilot lights and color of cover plate with Owner's Representative.
2. Polycarbonate or steel wall box.
3. Wall plate color to match wall color. Color options shall include: ivory, white, black or stainless steel.

4. Continuous color indication. LED lights, 20-25 mm diameter. One green light located above one red light.
5. Voltage as selected by BAS installer, 12-volt or 24-volt, 20 mA, maximum.
6. Manufacturers: Signaworks #WP22 Series or equal.

T. Flow Switch
1. Paddle type vane flow switch for insertion into pipe sizes 1” to 8”. Forged brass body, stainless steel vane, and tin-bronze bellows. Maximum operating temperature to 230°F (110°C) and maximum operating pressure to 145 psig (10 bar). NEMA 4 enclosure, SPDT snap switch, 250 VAC (max). Connection using 1” male NPT or BSPT. Switch must be installed vertically on a horizontal pipe run.
2. Manufacturers: Dwyer #FS-2, or equal.

2.11 ACTUATORS

A. Electronic Actuators:
1. Size for torque required for damper seal at load conditions.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
4. Overload protected electronically throughout rotation.
5. Fail-Safe Operation: Mechanical, spring-return mechanism
6. Electronic Fail-Safe Operation: Incorporate a visual indication of the fail safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10% increments. The electronic fail safe shall have a 2-10 second adjustable operational delay.
7. Power Requirements (Spring Return): 24-V ac, maximum 10 VA at 24-V ac or 8 W at 24-V dc (running). Maximum 1 VA at 24-V ac or 1 W at 24-V dc (holding).
8. Proportional Actuators shall be fully programmable through an onboard EEPROM by using an external cable and software interface.
9. Temperature Rating: -22 to +122ºF.
10. Housing: Minimum requirement NEMA type 2 mounted in any orientation. .
11. Agency Listings: ISO 9001, cULus, CE or CSA
12. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
13. Manufacturers: Belimo, Siemens, Honeywell, Keystone #777, or equal.

B. Actuators with torque requirements exceeding 360 inch-pounds:
1. The combination of valve and actuator shall meet the close-off requirements as specified in Section 2.16.H – Butterfly Valves.
2. Coupling: ISO 5211 mounting standards.
3. Overload Protection: A self-resetting thermal switch embedded in the motor.
4. Manual Override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure
5. Power Requirements: 24VAC, 120VAC, or 230VAC single phase.
6. Auxiliary Switches: 2 SPDT rated 3A at 250 VAC.
7. Temperature Rating: -22 to +122ºF.
8. Duty Cycle Rated 75% minimum.
9. Housing: Minimum requirement NEMA type 4X/ IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within

the housing. A visual indication beacon shall indicate position status of the device.

10. Agency Listing: ISO, CE, CSA
11. The manufacturer shall warrant for 2 years from the date of production.
12. Manufacturers: Belimo, Siemens, Honeywell, or equal.

2.12 CONTROL VALVES

A. Manufacturer: Belimo, Siemens, Honeywell, or equal.

B. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

C. Control Valve Actuators:
1. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
2. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad.
3. Non-spring return actuators shall have manual override
4. Spring return actuators of 90 inch-pounds or above shall have manual override.

D. Control Valves:
1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. Sizing (Water):
   a. Two-Position: Line size or size using a pressure differential of 1 psi.
   b. Two-Way Modulating: Size for a pressure differential across the valve of 4 psi at design flow, or twice the load pressure drop at design flow.
   c. Three-Way Modulating: Size for a pressure differential across the valve of not more than 4 psi at design flow
3. Sizing (Steam):
   a. Two-Position: Line size or sized using 10% of inlet gauge pressure.
   b. Modulating: 15 psig or less inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 15 psig inlet steam pressure the pressure drop shall be 42% of the inlet absolute pressure.
4. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves.
5. The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

E. Pressure Independent Control Valves:
1. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc for equal percentage characteristic.
2. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.

3. The control valve assembly shall have an integral magnetic flow meter Magnetic flow meter to accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
4. Flow Characteristics: NPS 1/2" through 2" Equal percentage characteristic. NPS 2-1/2" through 6" capable of Equal percentage or Linear characteristic (field programmable).
5. All proportional actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
6. Actuators for 3-wire floating (tri-state) and on 2 position (on/off) on 1/2" to 1" pressure independent control valves shall fail in place.
7. Water Coil optimization 2-1/2" through 6" shall be accomplished by utilizing an energy meter (a pressure independent control valve assembly) with two integral temperature sensors providing feedback of coil inlet and coil outlet water temperature; and integral magnetic flow meter for control and to provide actual analog flow feedback. Valve assembly to have built in intelligence to control pressure independently and a Delta T Manager mode to mitigate low delta T syndrome by referencing an internally programmed design delta T setpoint. Valve assembly shall be capable of communicating data by means of BACnet MS/TP, BACnet I/P and TCP IP. Data to include, but not be limited to, inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr. Valve assembly shall be capable of trending and storing up to 13 months of data on the actuator. Trended data on actuator to be retrievable via TCP IP or direct connect and download to *.csv file format.
8. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).
9. The control valve shall require no maintenance and shall not include replaceable cartridges.
10. NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent with strainer/shut-off valve/drain with pressure/temperature test ports. The return side shall contain a union fitting with a pressure/temperature test port, pressure independent control valve, and integrated isolation ball valve/manual air vent with a pressure/temperature test port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A braided stainless flexible hose shall be provided for each coil supply and return connection for all pipe packages.

F. Characterized Control Valves:
1. NPS 1/2" and smaller for Terminal Units: Nickel plated forged brass body rated at no less than 600 psi WOG Water oil gas, chrome plated brass Stainless steel stem is an option ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

2. NPS 1” through 2”: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
3. NPS 2-1/2” through 6”: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
4. Flow Characteristics: Equal percentage characteristics.
5. Six-way control valve used for chilled beam applications shall have the following characteristics:
    a. NPS 1/2” and 3/4”: Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems, and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
    b. The six-way control valve shall be controlled by a rotary actuator for managing two media in a modulating application. The valve shall be closed to all flow at mid-rotation.

G. Butterfly Valves – Resilient Seat:
1. NPS 2 to 12: Valve body shall be full lugged cast iron to meet ANSI 150 or 300 standards, with a 304/316/416 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. The shaft shall be supported at four locations by reinforced PTFE bushings.
2. NPS 14 and Larger: Valve body shall be full lugged cast or ductile iron to meet ANSI 150 or 300 standards, with a 304/316/416 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by reinforced PTFE bushings.
3. Sizing:
    a. Two-Position: Line size or size using a pressure differential of 1 psi.
    b. Modulating: 4 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position and a design velocity not to exceed 12 feet per second.
4. Close-Off Pressure Rating: NPS 2-12” 200 psi bubble tight shut-off. NPS 14 and larger, 150 psi bubble tight shut-off.

H. Butterfly Valves – High Performance:
1. Valve body shall be full lugged carbon steel body to meet ANSI Class 150 or 300 standards, as required, with a 316/416 stainless steel disc without a nylon coating, reinforced PTFE seat, and meet ANSI Class 150/300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed PTFE bushings. Valve packing shall be PTFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2” insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.
2. Sizing:
    a. Two-Position: Line size or size using a pressure differential of 1 psi.

b. Modulating: 4 psig, or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position with the design velocity less than 32 feet per second.

3. Flow Characteristics: Modified equal percentage, unidirectional.
4. Close-Off Pressure Rating: 150 psi bubble tight shut-off.
5. Media Temperature Range: ANSI Class 150 limitations.
6. Max Differential Pressure: 285 psi @ 100°F for ANSI 150 (725 psi @ 100°F for ANSI 300).

I. Equipment Isolation Valves:

1. Slow Closing/Quick Opening Solenoid Valve (2-Way/2-Position), 1/2” to 2-1/2”:
   a. Class 125, brass body, stainless steel core, snubber slows disc closing to protect system against water hammer, minimum operating pressure differential 5 psi, 120 VAC input, normally closed (closed when deenergized). Lead-free construction and UL/NSF compliant. Valve shall full stroke close in 4 to 10 seconds and open immediately when energized. Manufacturers: Asco Redhat #8221 or equal.
2. Butterfly Valves, 2-1/2” and larger:
   a. Valve body shall be full lugged cast iron body and shall meet ANSI Class 125/150 flange standards. Disk shall be aluminum bronze or 304/316/416 stainless steel with EPDM seat and extended neck as required to accommodate insulation. The shaft shall be supported at four locations by reinforced PTFE bushings.
   b. Valve actuator with integrated linkage for 90° degree rotation and visual position indicator. Power supply with input voltage from 24 to 240 VAC. Power consumption in operation 20 watts and resting power consumption of 6 watts maximum. Adjustable running time of 30 to 120 seconds for full stroke. Ambient humidity to 95% RH non-condensing and operating temperature from -22°F to 122°F (-30°C to 50°C). Die cast aluminum Type 4X enclosure. Open/close or floating point operation as required by system operation. Manufacturer: Belimo #PR Series or equal.

2.13 ENERGY VALVE

A. NPS 1/2” through 2”:

1. 2-way characterized control valve with tight close-off. Nickel-plated forged brass body rated at no less than 360 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and flow characterizing disc.
2. Non-spring return or electronic fail-safe actuator with analog input and output
3. Ultrasonic flow meter with temperature and glycol compensation.
4. Supply and return temperature sensors with thermowells and pipe fittings.

B. NPS 2-1/2” through 6”:

1. 2-way characterized control valve with tight close-off. GG25 cast iron body according to ANSI Class 125 or Class 250 per system pressure class, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125/250 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.
2. Non-spring return or electronic fail-safe actuator with analog input and output
3. Magnetic flow sensor.
4. Supply temperature sensor with thermowell.
5. Return temperature sensor embedded.

C. Manufacturer: Belimo.

2.14 DOMESTIC WATER SECURITY VALVES

A. Scope: connect to BAS for automatic opening and closing of domestic cold water supply to building.

B. Control Valve Actuator:
1. High torque actuator, fast opening and closing to control incoming domestic cold water service.
2. NEMA 6P waterproof enclosure.
3. UL listed.
4. Power supply input:100–240 volts, 60 Hz, 1 amp maximum. Output 18 volts, 2.22 amps.
5. BAS feedback signals for valve open or closed.
6. 12 VDC trigger contact to open valve.

C. Control Valve:
1. 316 stainless steel, 3-piece construction for body, ball and stem.
2. Equipped with a manual handle for emergency override.
3. Pressure rated to 600 psi, minimum.
4. Full port ball valve.
5. Threaded for sizes 1/2” to 2”.

D. Low lead and certified for potable water use per UPC and NSF/ANSI 61.

E. Manufacturer: Automatic Security Valves, or equal.

2.15 WIRELESS SYSTEM

A. Architecture and Communications:
1. Wireless equipment controllers and control devices shall conform to IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems. Equipment shall also comply with the following standards:
   a. UL 916: Energy Management Equipment
   b. UL 94: The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating
   c. UL 873: Temperature regulating and indicating equipment
   d. ZigBee Building Automation
   e. BACnet Tunneling
2. Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
3. Operating range shall be a minimum of 200 feet; open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to ensure reliable operation.
4. To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
5. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
6. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E.
7. The system devices shall use direct sequence spread spectrum RF technology.
8. The system devices shall operate on the 2.4 GHZ ISM Band.

9. The system devices shall be FCC compliant to CFR Part 15 subpart B Class A.

B. Service Tools:
   1. To support network setup and troubleshooting, service tools shall display link quality and hop quantities for each wireless device.
   2. Wireless service tool access to communication link shall be provided to minimize installation and troubleshooting labor.

C. Construction:
   1. Devices such as sensors, receivers and signal coordinators, intended to be installed in a return air plenum, shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB. Wall mounted devices may be assembled in NEMA-1 plastic enclosures.

D. Wireless Field Bus System:
   1. The system shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for BACnet devices at multiple system levels. This includes communications from field controllers to sensors and from sensors to field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.
   2. The field bus coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a coordinator for initiation and formation of the network
      a. The coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
      b. The coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
      c. The coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
   3. A wireless field bus router shall be used with any controller and field device to provide a wireless interface to supervisory devices and associated wireless mesh room temperature sensors.
      a. The router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
      b. The router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
      c. The router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

E. Wireless Room Temperature Sensors:
   1. Wireless space sensors shall be capable of continuous operation in the following conditions:
      a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
      b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
   2. Wireless room temperature sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated router.
      a. The sensors shall be available with:
         1) Warmer/cooler setpoint adjustment or no setpoint adjustment.

2) Setpoint adjustment scale: 55°F to 85º F (minimum range).

b. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in the schedules.

3. Features:
   a. The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.
   b. To check for proper operation, wireless space temperature sensors shall include signal strength on the space sensor display.
   c. To support use by the physically impaired, the wireless space sensor shall be a minimum font size of 12 points, and the LCD model shall be readable in low light conditions.
   d. An optional 2% relative humidity sensors module shall be available for humidity control applications to minimize the need for wired sensors, and shall not shorten typical battery life to less than 15 years.
   e. Wireless space sensors shall be available as: temperature only, field configurable model with digital display, and optional 2% humidity module for use in either model above. The field configurable models shall all allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.
   f. The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.
   g. The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.
   h. The wireless space sensor shall include security screws to protect against theft.
4. Accuracy:
   a. To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing. When the space temperature is rapidly changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be +/- 0.5°F (+/- 0.28°C).

F. Wireless Communications Interface:
1. Wireless communication devices and receivers shall be capable of continuous operation in the following conditions:
   a. Ambient operating temperature range shall be 32°F to 122°F (0 to 50°C).
   b. Ambient operating and storage humidity range shall be 5 to 95%, non-condensing.
2. Features:
   a. Wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing.

G. Many-To-One Wireless Receiver:
1. The Many-To-One System Receiver shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple wireless room temperature sensors.
2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
3. The receiver shall be capable of communication with sensors up to a distance of 200 Feet.
4. The receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
5. The receiver shall have LED indicators to provide information regarding the following conditions:
   a. Power: on/off.
   b. Ethernet: receiver activity/no activity.
   c. Wireless Normal Mode: transmission from sensors/no transmission.
   d. Wireless Rapid Transmit Mode: no transmission/weak signal/adequate signal/excellent signal.
   e. Ethernet Connection: No connection/10Mbps connection/100Mbps connection
   f. Network Activity: No network activity/half-duplex communication/full-duplex communication.

H. One-to-One Wireless Receiver:
1. The One-To-One Wireless Receiver shall receive wireless radio frequency (RF) signals containing temperature data from multiple wireless room temperature sensors and communicate this information to field controllers via the communication bus.
2. The receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
3. The receiver shall be capable of communication with from one to five sensors up to a distance of 200 Feet.
4. The receiver shall have LED indicators to provide information regarding the following conditions:
   a. Power.
   b. Communication Bus: Receiver activity/no activity.
   c. Wireless RF: Transmission from sensors/no transmission.
   d. Wireless Rapid Transmit Mode: No transmission/weak signal/adequate signal/excellent signal.

I. System Tools:
1. Wireless Space Sensor Installation and Configuration Tools
   a. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the contractor use for system installation and commissioning for the duration of the warranty period.
   b. To enable installation and servicing when specialized tools are required, site survey and installation tools as well as software shall be provided to the Owner for permanent possession for ongoing system maintenance and trouble shooting.

2.16 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment.

C. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

D. Outdoor enclosures shall be NEMA 3R or NEMA 4X, as necessary for the site.

E. Enclosures shall have hinged, locking doors.

F. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

2.17 PROGRAMMABLE THERMOSTAT

A. Thermostat with 365 day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
   1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One or equal.

B. Minimum thermostat features shall include, but not limited to, the following:
   1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
   2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
   3. The setback override shall be activated by a single button, and deactivated on demand.
   4. Setpoints shall be adjustable from 35°F to 99°F, with a minimum 5°F adjustable deadband available.
   5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75°F and heating setpoint of 70°F. Initial unoccupied mode cooling setpoint of 85°F and heating setpoint of 55°F.

C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
   1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
   2. Emergency Heat switch will be provided on the touch screen when set in heat pump mode.

D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.

E. Controls shall be capable of alternating compressor starting sequence with a built-in lead-lag operating logic.

1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.

F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.

G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the Owner’s Representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.02 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.03 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum three (3) feet of clear access space in front of units. Obtain approval on locations from Owner’s Representative prior to installation.

B. Wall mounted temperature sensors will typically be mounted directly above or below light switches and comply with ADA height requirements. Coordinate with Owner, Architect and other trades to assure proper mounted locations prior to installation.

C. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

D. Identify all equipment and panels. Provide permanently mounted tags for all panels.

E. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

3.04 CONDUIT

A. Conduit Requirements: all conduit shall with comply with minimum requirements of local authority having jurisdiction.
   1. Low voltage wiring in concealed areas may be plenum rated. Low voltage wiring in exposed areas shall be enclosed in conduit.
      a. All low voltage wiring exposed to weather shall be installed in conduit.
      b. Low voltage wiring in exposed areas, such as in mechanical, electrical, or service rooms, shall be installed in EMT conduit up to 10 feet above finished floor.
   2. All low voltage control wiring in critical facilities and critical locations shall be enclosed in conduit.

B. Provide rigid conduit for low voltage wring in walls for all wall mounted sensors, CO2 sensors, humidity sensors, etc. Conduit shall be run to 6” (minimum) above the ceiling and shall terminate with a bushing installed on the conduit end. Flexible conduit shall not be used.

C. Provide conduit for low voltage wiring above inaccessible ceilings.

D. Conceal all conduits, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 12 inches (30 cm) from high-temperature equipment (i.e.-such as flues or high temperature pipes).

E. Conduit must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

F. Secure conduits with conduit clamps fastened to the structure and spaced according to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

G. Size of conduit and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer’s recommendations and NEC requirements, except as noted elsewhere.

3.05 LOW VOLTAGE INTERLOCKING AND CONTROL WIRING

A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.

B. All low-voltage wiring shall meet NFPA-70 (NEC) Article 725 Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

C. Do not install Class 2 wiring (greater than 100 volts and protected by overcurrent device not over 20 amperes) in conduits containing Class 1 wiring (not exceeding 30 volts and 1000 volt-amperes). Boxes and panels containing line voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

D. Unless otherwise noted, power wiring for all valve and damper actuators is Class 2. If the BAS contractor desires to substitute 120-volt actuators, the BAS contractor shall coordinate directly with the General Contractor and Electrical Contractor to provide all 120-volt wiring and conduit at no additional cost to the Owner.

E. Contractor shall provide step-down transformers as necessary.

F. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of vertical conduits.

G. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block. Wire nuts are not acceptable.

H. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

I. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

J. Use color-coded conductors throughout with conductors of different colors.

K. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

L. The contractor shall terminate all communications, control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

3.06 COMMUNICATION WIRING

A. The contractor shall adhere to the wiring requirement previously listed.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling

C. Do not install communication wiring in conduits and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to manufacturer's instructions.

G. All runs of communication wiring shall be unspliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
   1. The network shall use shielded, twisted-pair or stranded cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). Wire gauge and wire type shall be sized and coordinated with manufacturer load requirements and lengths of runs.
   2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
   3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
   4. An MS/TP EIA-485 network shall have no T connections.

K. All Ethernet cabling, routers, hubs and switches for connecting 230900 furnished and installed control panels, servers and clients to the building Owner's Ethernet network are the responsibility of the BAS contractor.

3.07 MOTORIZED DAMPERS

A. Where ducts penetrate an exterior surface install a Class I motorized damper at each outdoor air supply opening, return air opening, exhaust opening, relief outlet, shaft vent and stairway vent, as required to comply with minimum requirements of the local Energy Code.
   1. Dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the system served requires outdoor air or exhaust air or operates continuously or the dampers are opened to provide intentional economizer cooling.
   2. Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

3.08 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation. Provide all labor and services as necessary to support testing and verification by third party commissioning authority.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

1.02 PROJECT RECORD DOCUMENTS

E. Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:
1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on optical media and as 11” x 17” prints.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: “Control System Demonstration and Acceptance.”
3. Operation and Maintenance (O & M) Manual.
4. As-built versions of submittal product data.
5. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
6. Operator’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
9. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
10. Graphic files, programs, and database on magnetic or optical media.
11. List of recommended parts with part numbers and suppliers.
12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
14. Licenses, guarantees, and warranty documents for equipment and systems.

15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

3.09 TRAINING

A. Provide application engineer to instruct Owner in operation of systems and equipment.

B. Provide system operator's training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.

C. Provide on-site training above as required, up to 16 hours as part of this contract.

D. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the Owner.

3.10 DEMONSTRATION

A. Demonstrate complete operating system to Owner's Representative.

B. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION

SECTION 23 09 02 - VARIABLE FREQUENCY DRIVES (VFD)

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. Furnish complete and operational VFD systems as shown on the plans. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Variable frequency drives (VFDs), with or without bypass, as scheduled on drawings.
   2. Controls and control connections.
   3. Electrical power connections.

1.03 RELATED WORK IN OTHER SECTIONS

A. Section 23 0500: Basic HVAC Materials and Methods

B. Section 23 0593: Testing, Adjusting and Balancing

C. Section 23 0900: Building Automation System (BAS) Controls

D. Section 23 2123: Hydronic Pumps

E. Section 23 7312: Custom Factory Air Handling Units

F. Division 26: Coordination of interface items between the Mechanical equipment and controls and the Electrical Work specified in Division 26.

1.04 DEFINITIONS

A. THD: Total Harmonic Distortion in %. RMS value of harmonic currents expressed as a percentage of fundamental current occurring at the fundamental frequency (60 Hz). This equals the square root of the sum of the squares of the amplitudes of the 2^{nd} through the 50^{th} harmonic currents, divided by the amplitude of the 1^{st} harmonic. Used for both voltage (THD_v) and current distortion (THD_i).

B. TDD: Total Demand Distortion in %. This equals the square root of the sum of the squares of the amplitudes of the 2^{nd} through the 50^{th} harmonic currents, divided by the amplitude of the maximum demand current of the facility. This is used by IEEE 519 to determine the harmonic current distortion that a facility presents to the utility. TDD is not the current distortion of any individual device.

C. RMS

1.05 QUALITY ASSURANCE

A. Supplier of VFD shall be solely responsible for assuring that the VFD shall work properly with the motor(s) being controlled. VFD supplier shall provide all materials and labor required to replace motors, bearing, shafts, etc. that may be incompatible with VFD or become damaged by VFD at no additional cost to the owner. VFD supplier shall reimburse Architect and Engineer at their standard hourly rates for their involvement in resolving failures due to their VFDs.

B. Manufacturer shall have a minimum of 15 years of experience building similar equipment for controlling the speed for induction motors and at least one hundred successful installations with a variety of VFD sizes and applications.

C. To reduce the known problem of bearing failures by "fluting" the VFD switching rates shall be 6-8 KHz wherever possible. Manufactured VFDs at switching rates of 12-15 KHz shall be accompanied by an additional extended warranty to cover bearings and motors to a period of ten (10) years. Shaft grounding is not required for EC motors with integrated speed controller. Acceptable manufacturers include Shaft Grounding Systems (www.shaft-grounding-systems.com) or Aegis Shaft Grounding Ring (www.est-aegis.com).

D. To ensure quality and minimize infantile failures at the job site, the VFD shall be burned in at the factory at an ambient of 104°F minimum for at least 8 hours. The VFD shall be operating a dynamometer and the load speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.

E. Standards and Guidelines: Provide VFDs conforming to the requirements of the latest addition of the following:
   1. UL 508: The UL Safety Standard for Industrial Control Equipment. All VFD equipment provided under this section must be labeled as UL 508 approved.
   2. ANSI/IEEE 518: Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources.
   3. ANSI/IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. This addresses the current distortion of a complete facility and not current distortion of individual pieces of equipment within the facility.
   4. International Standards Organization (ISO) certified 9001.
   5. International Building Code (IBC) seismic requirement referencing ASC 7 and ICC AC-156.
   6. International Electrotechnical Commission 60721-3c1, 2, & 3 Conformal coating
   7. NEC 430.120, Adjustable-Speed Drive Systems.
   8. NEMA ICS 7.0, Application Guide for AC Adjustable Speed Drives.
   9. AHJ approval or proof of special seismic certification for structures requiring it.
   10. RoHS (Restriction of Hazardous Substances) certified.
   11. SEMI F47-0706 for voltage sag immunity

F. Performance Standards: VFDs shall be tested and listed for drive system efficiency, motor insulation and power line harmonics conforming to the requirements of one, or more, of the latest addition of the following:
   1. AHRI 1210/1211: Performance Rating of Variable Frequency Drives.
   2. IEC 61800: Adjustable Speed Electrical Power Drive Systems.

1.06 QUALIFICATIONS

1. VFDs and options shall be UL 508 listed as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR without the need for external input fuses.
2. The entire VFD assembly, including the bypass (as scheduled on drawings), shall be seismically certified and labeled as such in accordance with the International Building Code (IBC) and local amendments:
   a. VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
   b. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156
   c. AHJ approval if needed.
3. Base VFD shall have CE Mark conforming to European Union Electromagnetic Compatibility directive, requiring VFD meet product standard EN 61800-3 for the First Environment restricted level (Category C2). Base drives that only meet the Second Environment (Category C3, C4) shall be supplied with filters to bring the drive in compliance with the First Environment levels.
4. VFD Enclosure to be UL rated: 1,12, 3R, 3RX, 4 or 4X as needed. Cabinets correctly sized for airflow and heat dissipation of drive with interlocked handle. Outdoor 3R enclosures include thermostatically controlled vent fans and heater. 4X shall be stainless steel cabinet with temperature controlled air-conditioned air isolated from outside air in the VFD cabinet. Self-certified UL enclosures not accepted.
5. Factory authorized start up and owner training should be provided locally upon request. A toll free 24/365 technical support line connected to factory support personnel located in the US shall be available
6. VFDs and bypasses shall be considered as an “end device” and not specifically listed as UL 864 UUKL compliant. However, VFDs shall be provided with control and override capabilities as required for smoke control.

1.07 SUBMITTALS

A. Prior to construction submit for approval the following materials:
   1. VFD supplier shall provide reference list showing at least ten years of prior manufacturing experience in production of VFDs and a list of at least twenty successful installations with a variety of VFD sizes and applications.
   2. Manufacturer's data, installation instructions, and maintenance and operational instructions for variable frequency drives. Indicate electrical service and special requirements. Include manufacturer's descriptive literature, repair data, and parts listing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units. Remove damaged equipment from site.

1.09 WARRANTY

A. Provide minimum two-year (24 months) warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB ACH580 (1 to 350 hp), ABB ACH880 (Ultra Low Harmonic Drive), ABB ACC55 (Micro Drive 0.25 to 3 hp). Or, equal by Danfoss, Allen-Bradley, Emerson, Schneider Electric (Square D), Toshiba, or Yaskawa.

2.02 GENERAL

A. Furnish a complete VFD as scheduled on the plans. Refer to plans for locations of variable speed controllers. Each fan or pump motor shall have a dedicated VFD unit. All standard and optional features shall be included within the VFD enclosure unless otherwise specified. The VFD enclosure shall be provided to match the environment requirements where the VFD will be mounted and operated. Provide NEMA/UL rated enclosure as required for environment.

B. The adjustable frequency controller shall convert three-phase, 60 Hz utility power to adjustable voltage and frequency, three-phase, AC power for stepless motor speed control from 10% to 100% of the motor's 60 Hz speed.

C. The VFD shall provide full rated output from a line of ±10% of nominal voltage. The VFD shall continue to operate without faulting from a line of +30% to -35% of nominal voltage. Overload rating of VFD shall be 110% of normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds every minute. VFDs shall be capable of continuous full load operation in the following environmental conditions:
   1. -15 to 40° C (5 to 104°F) ambient temperature. Operation to 50° C (122°F) shall be allowed with a 10% reduction from VFD full load current.
   2. Altitude 0 to 3300 feet above sea level. Operation to 6600 feet shall be allowed with a 10% reduction from VFD full load current.
   3. Humidity less than 95%, non-condensing.

D. The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to a DC voltage. Drive shall utilize a single surface mount micro-processor.

E. The VFD shall be of the pulse width modulation (PWM) type. VFDs shall be provided with an advanced flux vector frequency control to limit noise at drive and motor.

F. Drive manufacturer or sales representative shall evaluate electrical system of the project. Any additional protective equipment such as line filters, reactors or input isolation transformers required to prevent interference from drive with other electrical equipment in the building shall be included as part of the bid. No additional expense shall be incurred by Owner for provision or installation of these devices if required for electrical system operation after drive has been purchased. Units shall include factory mounted input line reactors.

G. The VFD maximum output current rating shall be 110% of the motor nameplate full load current. VFD shall be able to start into a rotating load in either direction without trip.

H. The VFD and options shall be tested to ASNI/EIA Standard 508 and listed by a nationally recognized testing agency such as UL or ETL.

I. The VFD and options shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and the National Electrical Code.

J. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in ANSI/IEEE Standard 519.

K. The drive efficiency shall be 97% (minimum) and have a fundamental power factor of 0.98 at all speeds.

2.03 BASIC FEATURES

A. The VFD shall be housed in a NEMA enclosure appropriate to the mounting location.
1. NEMA 12 enclosure shall be used indoors in dusty locations, plenum mechanical rooms, penthouses, or air stream mounting.
2. NEMA 3R is required for all outdoor locations exposed to falling rain, snow or ice or to indoor locations subject to falling water.
3. If NEMA 1 enclosure is suitable it shall be vented through cabinet and equipped with an integral cooling fan with thermostat control and arranged so that units can be mounted back to back on a frame and/or side to side on a wall. Venting fans shall be supplied in enclosure if required. If a different NEMA enclosure is indicated the enclosure shall provide means of maintaining the drive at temperature acceptable to the drive manufacturer in exterior ambient temperatures. Enclosure shall be complete with no requirements for low voltage wiring. Factory mounted main circuit breaker disconnect shall be included.

B. All circuit boards shall be coated to protect against corrosion. Control boards shall be conformal coated to at least IEC 60721-3c2.

C. All VFDs shall have the same HMI/keypad, with backlit digital display, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs. It shall incorporate “Bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. HMI/keypad shall include password protection against parameter changes.

D. The HMI/keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting. The display shall be in complete English words for programming and fault diagnostics (alphanumeric codes only are not acceptable.)

E. The HMI/keypad shall utilize pre-programmed application macros or templates specifically designed to facilitate start-up. The Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to

reduce programming time. The VFD shall have two user savable programs to allow the user to save custom settings.

F. HMI/keypad operating values shall be capable of being displayed in engineering units for sub-metering purposes [i.e. GPH, KW, Motor Amps, Frequency, Speed, Torque, etc.]. A minimum of three operating values shall be displayed at all times.

G. VFD shall have the option to support Bluetooth Advanced Control Panel and Apps. The Bluetooth control panel shall be FCC and QSL (Qualified Design Listing) certified.

H. VFD shall include built in coordinated AC transient surge protection system consisting of four MOVs (phase to phase & phase to ground), capacitor clamp, 1600 PIV Diode Bridge and internal chokes.

I. VFDs shall have 5% impedance AC reactors or internal dual 5% DC chokes to reduce harmonics to the power line and as protection from AC line transients. VFD's with only one DC choke shall have OEM add AC UL 508 listed and approved Chokes or line reactors. Maximum allowable total demand distortion shall not exceed 5% and the total harmonic distortion shall be less than 3%. VFDs using thin wall, small DC bus or metallic type capacitors must add active harmonic filters to prevent high frequency harmonics from corrupting the electrical system.

J. VFD shall automatically mitigate harmonics throughout the effective load range using Swinging chokes or other devices designed to lower harmonics when VFD is at partial loads.

K. VFDs shall include Ferrite Core EMI/RFI/Common mode filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level (Category C2).

L. The input current rating of the VFD shall not be greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.122.

M. VFDs shall be able to have a distance from the VFD to the motor of at least 250 feet at the maximum carrier frequency, or provide a DV/DT filter in addition to each VFD as needed to protect the motors.

N. VFD shall have its own standardized control board that is the same for all drive sizes, with all communications and I/O terminals on it, and standard BAS communications protocols to include ModBus RTU; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet MS/TP. All diagnostic warning and fault information shall be transmittable over serial communications. With Remote fault reset if programmed. Options available for: Ethernet IP, BACnet IP, ControlNet, DeviceNet, EtherCAT, Lonworks, ModBus TCP and Profibus. All protocols shall be "certified" by the governing authority. VFD shall have ability to provide feedback to the BAS for kWh, speed of drive, torque load, load curve status, current proof using built-in current sensors, alarm and faults indication, motor temperatures, and other input and output status conditions.

O. Two (2) programmable analog inputs shall accept 0-10VDC or 4-20 ma signals.

P. Two (2) programmable analog outputs 0-20ma or 4-20 ma signals. Outputs proportionally programmable for: Motor Current, Power, Speed, Torque, (kW) and other data.

Q. Minimum of six (6) programmable digital inputs for interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.

R. Minimum of three (3) programmable, Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. Rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts.

S. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others.

T. The VFD shall have Pass thru I/O- to allow the BAS to monitor and control the VFD/ bypass or its analog and digital outputs via communications. This control shall be independent of any VFD function and may be used to control or monitor any other device.

U. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and/or communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for “two zone” control. The PID set points shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.

V. The VFD shall have cooling fans that are designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required, based on the temperature and run command to the drive. VFD protection shall be based on thermal sensing and not cooling fan operation.

W. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery backup with a 10-year minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. VFD programming shall be held in non-volatile memory and is not dependent on battery power.

X. Drive options shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

Y. VFD shall include option for nonpowered programming via Laptop and adapter.

Z. VFD shall include option for a Bluetooth Advanced Control Panel. The Bluetooth control panel shall be FCC and QDL (Qualified Design Listing) certified. A free app (iOS and Android) shall replicate the control panel on a mobile device or tablet. The control panel’s programming and control functionality shall function on the device. Customizing text, such as AHU-1 End Switch, shall be supported by the device’s keyboard. Bluetooth connectivity shall allow uploading, downloading, and emailing of parameters. Bluetooth connectivity shall include two pairing modes-always

discoverable with a fixed passcode and manual discovery with a unique generated passcode every pairing.

2.04 PROGRAMMABLE ADJUSTMENTS

A. Three (3) programmable critical frequency lockout ranges (aka Skip or resonant) to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.

B. The VFD shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates.

C. Two independent adjustable acceleration and deceleration ramp times, adjustable from 1 to 1800 seconds, initial settings shall be 60 seconds set by manufacturer.

D. VFD shall include a motor flux optimization and noise smoothing circuits that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise.

E. VFD shall provide built-in current sensor with programmable loss-of-load (broken belt / broken coupling) option to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the BAS.

F. VFD shall have programmable “Sleep” and “Wake up” functions to allow the drive to be started and stopped from the level of a process feedback signal.

G. VFD to have two PID controls built in for VFD or other uses. PID controllers have ability for “two zone” control. PID set points adjustable from the VFD keypad, analog inputs or BAS

H. If the input reference is lost, the VFD shall be programmable to: (1) stop and display a fault, (2) run at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) go to a backup control system wired to the VFD. As well as cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the communication bus.

I. VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time and time between attempts shall be programmable. VFD shall be initially set to perform at least five (5) restarts after a power outage, drive fault or external fault before requiring manual reset. After ten minutes of runtime, the restart attempts return to zero. The VFD shall display a countdown timer when auto restart is being attempted, or incorporate programming to select number of restarts, number of faults per time period, and time between restarts.

J. VFD shall be capable of starting into a coasting load (flying start or forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage.

K. VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command.

L. Micro Drive VFDs shall have the following features and programmability:
1. Each Micro Drive shall have a HMI/keypad with Hand-Off-Auto modes, manual speed control, fault reset on it and ability to program the VFD for all functions. Ability to save VFD program preferred.
2. Each Micro Drive shall have the ability to run on single phase of power when derated 50%.
3. Each Micro Drive shall have at least one analog input and digital inputs and outputs built in when needed.
4. Each Micro Drive when needed shall have BAS communications protocols to include: ModBus RTU; Johnson Controls N2, and BACnet MS/TP are preferred.

2.05 PROTECTIVE FEATURES

A. A minimum of Class 20 I^2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

B. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

C. Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

D. Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

E. Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.

F. The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

G. VFD shall include a “signal loss detection” algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

H. VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.

I. VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

J. Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

K. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

L. If the temperature of the VFD’s heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD’s temperature becomes too high.

M. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

N. The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

O. The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

P. When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.06 BYPASS

A. Bypasses shall be a complete assembly UL 508 listed, furnished and mounted by the OEM as defined on the VFD schedule. All bypasses shall have a service Disconnect switch with two (2) contactor operation. They shall also have a UL rating of SCCR of 100,000 Amps.
   1. Factory wired and tested system with door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting Drive Isolation input fuses. UL Listed motor electronic overload protection Class 10, 20, or 30 (programmable) shall be included in both drive and bypass modes.
   2. The drive and bypass package shall be Seismic certified and labeled to IBC 2012:

3. Rating of 1.5 is required and based upon actual shake table test defined by ICC AC-156.
4. AHJ preapproval as needed.
5. Bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair/replacement. Bypass can be controlled by inputs, locally or by communications.
6. Bypass designs must allow qualified person to work on or remove bypassed VFD for service and allow bypass to continue to run system. Only approved per NEC 430.103 service disconnect switch with two (2) contactors should be used. Three contactor or "isolation contactors" are not an acceptable alternative to fuses and are not an NEC recognized disconnecting device for LOTO.
7. Bypass shall have its own standardized control board that is the same for all drive sizes, with all communications and I/O terminals on it. The keypad and two line (minimum), 20 character LCD display to control or program unit, read status and reset faults. Bypass shall have preset macros with user programmable options. As well as let user select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions: Over current, Over voltage, Under voltage or Loss of analog input.
8. Bypass shall have its own built in communications protocols that include ModBus RTU; Johnson Controls N2; Siemens Building Technologies FLN(P1); and BACnet MS/TP. All bypass diagnostic warning and fault information shall be transmitted over the communications. With Remote bypass fault reset if programmed. Options available for Lonworks, ControlNet and DeviceNet.
9. Bypass shall have Pass-Through analog and digital Inputs and Outputs that are capable of being monitored and/or controlled via serial communications for the drive or other devices.
10. Bypass shall have a proof of flow and broken belt adjustable motor current sensing circuit for bypass and VFD modes, condition shall be indicated on keypad display or over the BAS.
11. Bypass shall have six 24VDC digital inputs on its own separate terminal strip and incorporate an internally sourced 24VDC 250 mA power supply for use by itself or others to power external devices and not require an external control power source.
12. The bypass shall include a supervisory control mode. In bypass mode it shall monitor the value of the VFD's analog input (feedback). This feedback is used to control the bypass contactor on and off to maintain hysteresis control over applications such as cooling towers and booster pumps.
13. The user shall be able to select text to be displayed on the keypad when an external safety opens. Such as "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
14. Bypass shall meet requirements of SEMI F47-0706 for voltage sag immunity and maintain positive contactor control with a +30%, -35% tolerance of nominal voltage. This feature is designed to avoid contactor coil failure during brown out/low line conditions and allow for single-phase operation in VFD mode. Designs that will not allow single-phase operation in VFD mode and meet F47 are not acceptable.
15. Single phase Motor protection bypass must be able to detect a single phase condition IF VFD is running and prevent transfer as well as detect single phase power condition if it occurs while running or trying to start in bypass, disengage

the motor in a controlled fashion, and give a single phase input power indication locally and to BAS if programmed. Bypass systems not incorporating single-phase protection in bypass mode are not acceptable.

16. Earth or ground fault motor protection bypass system must be able to detect earth or ground fault if VFD is running and prevent transfer as well as detect if a ground fault condition occurs while running or trying to start in bypass, disengage the motor in a controlled fashion, and give a clear message of earth or ground fault locally and to BAS if programmed. Bypass systems not incorporating earth or ground fault protection in bypass mode are not acceptable.
17. The bypass control shall include a programmable time delay bypass start with keypad indication of time delay. A Form C relay output commands the VAV boxes to open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 to 120 seconds.
18. Smoke Control Override Mode (Override 1): The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire/Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User's Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
19. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Verify that mounting surface is ready to receive work. Mount the VFD(s) on the wall or at supports in locations identified on the drawings. Provide a layout drawing of VFD locations to electrical installer.

B. If the disconnect for the equipment powered by the VFD is in a location where it is probable that it will be placed in an off position prior to shutting down the VFD, the contractor is to provide electrical protection for the VFD. This may be in the form of a conduit and wire interlock between disconnect and drive or internal protection integral to the VFD.

C. Coordinate wiring and control with Control Contractor. Control installers shall install all wiring associated with control signals into the VFD and for interlock control wiring between disconnects and VFDs.

D. Electrical installer shall install all line voltage power wiring and conduit from electrical switchgear and from the VFD to the disconnect at the controlled motor. The only

exception to this is when the motor and drive are factory installed on a packaged piece of equipment. In that case the wiring from drive to motor is to be installed in the factory to meet the requirements herein. Coordinate with Division 26 work.

E. Line length between VFD and driven motor shall be as short as possible. Line length shall not exceed twenty (20) feet without prior approval from Engineer.

F. Input and output power wiring shall be installed in separate grounded conduit. In addition, control wiring shall be installed in its own separate grounded conduit.

G. Use symmetric motor cable between the VFD and motor, with low inductance shield or conduit, and with all joints joined with bonding straps. MC metal clad 3 phase type cable per NEC 334-1, UL approved, 3 phase conductors and 3 ground conductors. Sheath to be continuous corrugated aluminum. Manufacturer and type to be BICC 2 kV rated Drives Cable, Anixter series 7V, or approved equal.

H. Use cable connectors with 360-degree connections to the armor conduit at both ends of motor cable. Verify electrical path from inverter cabinet entry plate to armor / conduit to motor terminal box.

I. Install an auxiliary high frequency bonding connection for potential equalization between VFD frame and building steel.

J. Unless absolutely necessary do not install disconnect between VFD and connected motor. VFD is to be furnished with a lockable disconnect.

K. Installation in Air Handlers multiple fan arrays: When a single VFD supplies multiple fans, assemble and prewire units at the factory, installing conduit and conductors between the fan motor, VFD, and terminal strips. Wiring from the VFD output terminals to the fan motor shall be Belden VFD Cable installed in conduit (295XX Series).

3.02 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify control wiring, verify power wiring, start-up the drive, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

B. Carrier frequency setup:
1. Set initial carrier frequency at 2 kHz.
2. Manually raise VFD speed output from 10 Hz to 60 Hz by 10 Hz increments, allowing at least 15 seconds between each adjustment. If excessive motor noise is heard at any speed, raise carrier frequency by 2 kHz increments until motor noise is no longer excessive. Do not set carrier frequency higher than 10 kHz.
3. If excessive motor noise continues to be heard at or below 10 kHz, inform owner. If the motor is provided by the VFD manufacturer, either repair, replace, or provide 5 year extended warranty on the effected motor.

C. Lockout of resonant frequencies:

1. With carrier frequency set per the above specification, manually and slowly raise VFD speed output from 10 Hz to 60 Hz by 1 Hz increments. If excessive motor, frame, or driven load noise is heard at any speed, lock out that frequency.
2. Each frequency skip shall be programmed with as narrow a bandwidth as possible, while still avoiding the most objectionable range of resonant frequencies. Each frequency skip bandwidth shall not exceed 5 Hz without approval by Engineer.

D. Training:
   1. Provide one (1) hour training session to the Owner's Representative.
   2. Training to include:
      a. Demonstration of operation of bypass switch and door-mounted disconnect switches. Explain emergency operation.
      b. Demonstrate operation of operator keypads for viewing data and setting parameters.
      c. Demonstrate operation in manual mode, including setting of specific speeds.
      d. Explain the drive parameters that might require operator adjustment.
      e. Describe troubleshooting techniques and warranty procedure.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. Includes, but not limited to:
1. Furnish and install piping and piping specialties for refrigeration systems serving split system air conditioning units.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods.

B. Section 23 0719: HVAC Piping Insulation.

C. Section 23 8126: Split Gas Furnace/Air Conditioning Units.

D. Section 23 8145: Split Heat Pump Units.

E. Division 26: Electrical.

1.04 QUALITY ASSURANCE

A. Codes and Standards: Comply with the requirements of the latest addition of the following:
1. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications" latest edition.
2. ASHRAE 15: Safety Code for Refrigeration Systems.
3. ASME B31.5: Refrigeration Piping and Heat Transfer Components.
4. ASTM B 280: Specification for Seamless Copper Tube for Air Conditioning & Refrigeration Field Service.

B. Contractor Qualifications: A refrigeration contractor licensed by the State shall install refrigerant piping.

C. Manufacturer Qualifications:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.
   3. Manufacturer shall have a minimum of five years of manufacturing products related to refrigerant piping and/or fittings.
   4. Products shall have an installation history of no less than five years of field operation with reliable maintenance track record.
   5. Alternate system and material must be submitted with historical supporting documentation and reliability report before approval is allowed.

D. Codes and Standards:
   1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
   2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes for work required, but not specifically shown in Drawings.
   3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
   4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.

E. Product Control
   1. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
   2. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. Should it be necessary to deviate from arrangement or location indicated in order to meet existing conditions or due to interference with work of other trades, such deviations as offsets, pipe sizes, fittings sizes, rises and drops in piping that may be necessary, whether shown or not, shall be made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.
   3. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
   4. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.

5. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
6. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.
7. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.
8. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Owner’s Representative and receive clarification before installing the work.
9. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.
10. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.
11. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired.

F. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for all refrigerant piping, valves and specialties indicating dimensions, flow capacity, pressure setting, tolerances etc.

B. Shop Drawings:
   1. Submit shop drawings including plans, schematics, and riser diagrams of refrigerant piping, including dimensions of all piping.
   2. Reference to associated insulation systems submitted in compliance with Section 230719 HVAC Piping Insulation.
   3. Provide all details of suspension and support for ceiling hung equipment.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, valve replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.07 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

C. Provide the following additional extended warranty requirements that apply to piping with mechanical type joints and fittings, such as grooved or pressed/compression type fittings.
   1. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.
   2. Contractor and Manufacturer warrant that, for a period of ten (10) years from the date of Substantial Completion, the entire system, including but not limited to the fittings and joints, will conform to the requirements of the Contract Documents, will be free from defects, and will not leak.
   3. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:
   1. Suction Lines for Air-Conditioning Applications: 115 psig (793 kPa).
   2. Suction Lines for Heat-Pump Applications: 225 psig (1551 kPa).
   3. Hot-Gas and Liquid Lines: 225 psig (1551 kPa).

B. Line Test Pressure for Refrigerant R-407C:
   1. Suction Lines for Air-Conditioning Applications: 230 psig (1586 kPa).
   2. Suction Lines for Heat-Pump Applications: 380 psig (2620 kPa).
   3. Hot-Gas and Liquid Lines: 380 psig (2620 kPa).

C. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
   2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
   3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

D. Do not use pre-charged refrigerant lines more than 50 feet in length.

2.02 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B88, Type K or L; or ASTM B280, Type ACR.

B. Wrought-Copper Fittings and Unions: ASME B16.22.

C. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

D. Flux: Stay-Silv white brazing flux by J.W. Harris Co or silver solder flux by Handy & Harmon.

E. Brazing Filler Metals: AWS A5.8.
   1. Copper to Copper Connections:
      a. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
      b. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
   2. Copper to Brass or Copper to Steel Connections
      a. AWS Classification BAg-5 Silver (45% silver)
   3. Do not use rods containing Cadmium.

F. Manufacturers: Mueller Streamline, Nibco, Grinnell, Elkhart, or equal.

2.03 FLEXIBLE CONNECTORS

A. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

B. End Connections: Socket ends.

C. Offset Performance: Capable of minimum 3/4 inch (20 mm) misalignment in minimum 7 inch (180 mm) long assembly.

D. Working Pressure Rating: Factory test at minimum 450 psig (3100 kPa).

E. Maximum Operating Temperature: 250°F (121°C).

F. Manufacturers: Metraflex #RAF or equal.

2.04 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 F (135 C).

B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 F (135 C).

C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 275 F (135 C).

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.

3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Manufacturers: Apollo Valves (Conbraco), Henry, Mueller, Superior, Virginia, or equal.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24/115/208-volt ac coil as required.
6. Working Pressure Rating: 400 psig (2760 kPa).
7. Maximum Operating Temperature: 240 F (116 C).

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig (2760 kPa).
6. Maximum Operating Temperature: 240 F (116 C).

G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Reverse-flow option (for heat-pump applications).
6. End Connections: Socket, flare, or threaded union.
7. Manufacturers: Alco, Henry, Mueller, Parker, Singer, Sporlan, or equal.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter and 24/115/208-volt AC coil as required.
7. End Connections: Socket.

8. Throttling Range: Maximum 5 psig (34 kPa).
9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 240 F (116 C).

I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig (3450 kPa).
5. Maximum Operating Temperature: 275 F (135 C).

J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Maximum Operating Temperature: 275 F (135 C).

K. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 F (116 C).

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10-micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement for suction-line filter dryers.
6. Maximum Pressure Loss: **2 psig (14 kPa)**.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 240 F (116 C).

M. Permanent Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell.
2. Filter Media: 10-micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. End Connections: Socket.

5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: **2 psig (14 kPa)**.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 240 F (116 C).
9. Manufacturers: Alco, Mueller, Parker, Sporlan, Virginia, or equal.

N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 F (135 C).

O. Receivers: Comply with AHRI 495.
1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL for receivers larger than 6 inches (150 mm).
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 F (135 C).

P. Liquid Accumulators: Comply with AHRI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 F (135 C).

Q. Sight Glass
1. Combination moisture and liquid indicator with protection cap.
2. Sight glass shall be full line size.
3. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.
4. Manufacturers: Alco, Asco, Mueller, Parker, Sporlan, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide and install refrigerant piping, fittings, valves and devices as required by equipment manufacturer and as shown on the Drawings.

B. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
   1. No soft solder (tin, lead, antimony) connections will be allowed in system.
   2. Braze valve, sight glass, and flexible connections.
   3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

C. Insulate all suction and hot gas lines. Insulate liquid lines where pipe may be in close contact to humans.

3.02 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at refrigerant piping connection to all equipment (coils, condensers, and/or compressors) as required by the manufacturer and where necessary to prevent vibration from transferring into the building structure and to minimize vibration and audible noise in occupied spaces.

3.03 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective chaseway where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Install sleeves and escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Steel pipe: Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.05 HANGERS AND SUPPORTS

A. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
   2. Spring hangers to support vertical runs.
   3. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

B. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
   1. Up to NPS 5/8”(DN 18): Maximum span, 60” (1500 mm); minimum rod, 3/8” (9.5 mm).
   2. Greater than 5/8” up to NPS 1-1/8” (DN 25): Maximum span, 72” (1800 mm); minimum rod, 3/8” (9.5 mm).
   3. Greater than 1-1/8” up to NPS 2” (DN50): Maximum span, 96” (2400 mm); minimum rod, 3/8” (9.5 mm).
   4. NPS 2-1/2” (DN 65): Maximum span, 108” (2700 mm); minimum rod, 3/8” (9.5 mm).

5. NPS 3” (DN 80): Maximum span, 10 feet (3 m); minimum rod, 3/8” (9.5 mm).
6. NPS 4” (DN 100): Maximum span, 12 feet (3.7 m); minimum rod, 1/2” (13 mm).

C. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2” (DN 50): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
2. NPS 2-1/2” (DN 65): Maximum span, 11 feet (3.4 m); minimum rod, 3/8 inch (9.5 mm).
3. NPS 3” (DN 80): Maximum span, 12 feet (3.7 m); minimum rod, 3/8 inch (9.5 mm).
4. NPS 4” (DN 100): Maximum span, 14 feet (4.3 m); minimum rod, 1/2 inch (13 mm).

D. Support multifloor vertical runs at each floor.

3.06 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
4. Prepare test and inspection reports.

3.07 SYSTEM CHARGING

A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13 - AIR DISTRIBUTION

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Ductwork - Rigid, Flexible and Fabric.
   2. Diffusers, Grilles, and Registers.
   3. Ductwork Specialties.
   4. Flexible Connections.
   5. Sealants, Adhesives and Tapes.
   6. Duct Access Panels and Doors.
   7. Backdraft and Relief Dampers.
   8. Combination Fire and Smoke Dampers.
   9. Fire Dampers.
   10. Smoke Dampers.
   11. Control Dampers.
   12. Louvers.
   13. Flashings.
   14. Bird/Insect Screens.
   15. Sound Traps.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic Materials and Methods.

B. Section 23 0593: Testing, Adjusting and Balancing.

C. Section 23 0713: Duct Insulation.

D. Section 23 0900: Building Automation System (BAS) Control.

E. Division 26: Electrical.

1.04 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. ARI 885-98: Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminal and Air Outlets.
   2. AMCA-210: Laboratory Methods of Testing Fans for Rating Purposes.
   3. ANSI S12.23: Designation of Sound Power Emitted by Machinery and Equipment.
   4. ASC-A7001: Standard for Duct Sealants.
   5. ASHRAE Standard 130: Methods of Testing Air Terminal Units.
   6. AHRI Standard 885: Procedures for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
   7. NFPA 90A: Standards for the Installation of Air Conditioning and Ventilating Systems.
   8. NFPA 90B: Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   9. American Society for Testing and Materials (ASTM): Manufacture and test in accordance with the ASTM Standards, including:
      a. ASTM A167: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip. Type 304 or 304 stainless steel.
      b. ASTM A525: Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) Hot-Dip Process. G60 and G90 zinc-coated.
      c. ASTM A527/A527M: Standard Specification for Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
      d. ASTM C920: Standard Specification for Elastomeric Joint Sealants.
   10. Underwriters Laboratory (UL): Manufacture and test in accordance with the UL Standards, including:
      a. 181:Standard for Factory-Made Air Ducts and Air Connectors.
      b. 181A: Standard for Closure Systems for Use With Rigid Air Ducts.
      c. 181B: Standard for Closure Systems for Use With Flexible Air Ducts and Air Connectors.
      d. 268A: Standard for Smoke Detectors for Duct Application.
      e. 555: Standard for Fire Dampers.
      f. 555C: Standard for Ceiling Dampers.
      g. 555S: Standard for Smoke Dampers.
      h. 723: Standard for Test for Surface Burning Characteristics of Building Materials.
      i. 2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

B. Provide and construct ductwork systems in conformance with the latest editions of the following documents:
   1. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
   2. SMACNA HVAC Air Duct Leakage Test Manual.

3. SMACNA HVAC Phenolic Duct Construction Standards.
4. SMACNA - Accepted Industry Practice for Industrial Duct Construction" for duct pressures above +5" w.g. positive pressure or below -5" w.g. negative pressure. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards.
5. ASHRAE Systems and Equipment Handbook "Duct Construction" chapter.
6. ASHRAE Fundamentals Handbook "Duct Design" chapter.

C. Alternatives: The SMACNA standards and publications referenced in this Section of the specifications establish ductwork construction requirements.
1. Alternatives to these standards and publications may be submitted. Approval will be based on demonstration that such alternatives are equivalent and satisfy the functional requirements described in the referenced standards.
2. Such demonstration shall include evidence that the alternatives proposed were tested in accordance with SMACNA procedures and with test results certified by an independent testing laboratory.

D. All ductwork and equipment shall be seismically supported and braced to meet or exceed the minimum requirements of local building code requirements.

E. Flame/Smoke Rating: All materials, including sealants and adhesives, exposed within plenum shall be noncombustible or have a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method or UL 723. All materials installed within a plenum shall meet these requirements or have a safety data sheet available to indicate that materials are non-combustible. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Discrete plumbing, mechanical, and electrical products that are located in a plenum and have exposed combustible material shall be in accordance with UL 2043.

1.05 DEFINITIONS

A. Class 0: Factory-made air ducts and connectors, compliant with ANSI/UL 181, having a surface burning characteristic of zero. Typically constructed of semi-rigid corrugated aluminum. This does not include sheet metal ductwork constructed per SMACNA Standards.

B. Class 1: Factory-made air ducts and connectors, compliant with ANSI/UL 181, having a flame spread index of not over 25 and a smoke developed index of not more than 50. Typically constructed of flexible ductwork, rigid fiberglass ductwork and plastic ductwork. This does not include sheet metal ductwork constructed per SMACNA Standards.

C. Flexible Air Duct (Factory-Made): Class 0 or Class 1 air ducts tested in accordance with 15 tests per ANSI/UL 181 and installed in conformance with the conditions of the listing and NFPA 90A/90B. Flexible ducts shall not be installed to serve more than two stories and shall not penetrate a fire-resistance rated assembly or construction. Maximum lengths of flexible ductwork shall not exceed lengths identified in this section or as limited by the AHJ, whichever is shorter.

D. Flexible Duct Connector (Factory-Made): Class 0 or Class 1 connectors tested in accordance with 12 of 15 tests per ANSI/UL 181 and installed in conformance with the conditions of the listing and NFPA 90A/90B. Connectors include, but are not limited to, short flexible connections between air handlers and ductwork systems, uninsulated transition fittings, specialty shapes for diffuser connections, etc. Connectors shall not penetrate a wall, floor, or ceiling. Maximum lengths of flexible ductwork shall not exceed five-foot (5') lengths or as limited by the AHJ, whichever is shorter.

1.06 SUBMITTALS

A. Prior to construction, submit for approval on all materials and equipment:
1. Ductwork - Rigid, Flexible and Fabric.
2. Ductwork Specialties.
3. Flexible Connections.
4. Sealants, Adhesives and Tapes.
5. Flashings.
6. Bird/Insect Screens.
7. Duct Access Panels and Doors.
8. Backdraft Dampers.
9. Control Dampers.
10. Diffusers, Grilles, and Registers.
11. Fire/Smoke Dampers - Schedule of selected dampers must include the location, nominal size, free area velocity, and static pressure drop at free area velocity for each damper.
12. Sound Traps - Provide a table documenting anticipated pressure drop, insertion loss per octave band and self-noise at design conditions.
13. SMACNA "HVAC Duct Construction Standards - Metal and Flexible".

B. Shop Drawings: Provide shop drawings of sheet metal ductwork and plenums as follows:
1. Draw to a scale not less than 1/8" to one foot, with sheet sizes equal to Contract Drawings.
2. Show duct sizes, where possible use even duct sizes.
3. Show fitting details.
4. Show coordination with lighting fixtures, fire dampers, fire/smoke dampers, piping, diffusers, grilles, registers, fans, major electrical runs, cable trays and bus ducts.

C. Shop Drawings: Provide shop drawings for field erected mechanical equipment:
1. Draw to a scale of 1/2" to one foot, with sheet sizes equal to Contract Drawings.

2. Show plan, sections, elevations and details of all joints and enclosures.
3. Detail access doors and hardware.
4. Detail coil, damper, humidifier, filter and fan installations.
5. Show access space for electrical components that are part of the equipment provided and/or installed such as power and control panels on humidifiers. This shall be coordinated with Division 26 and NEC.

D. Certifications: Provide a duct schedule, certified by an officer of the sheet metal fabrication subcontractor, that the ductwork conforms to SMACNA standards, and for each sheet metal system furnished on the project include:
1. System name.
2. Duct material.
3. Duct gauge.
4. SMACNA rectangular reinforcement number.
5. SMACNA intermediate reinforcement number.
6. SMACNA transverse reinforcement number.
7. Rod diameter and type.
8. Sealant type.
9. Attachment method.
10. Duct system design pressure.

E. Construction IAQ Management Plan: Collaborate with the general contractor to submit and implement an IAQ Management Plan for the construction process meeting the requirements of the SMACNA IAQ Guidelines. This plan should address the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete. SMACNA IAQ Guideline recommends control measures in five areas. The IAQ Management Plan should address how compliance has been achieved in these required five areas as follows:
1. HVAC Protection
    a. Shutdown of return side of existing HVAC system in areas affected by heavy construction.
    b. Provision of temporary filters if existing or new systems must remain operational during construction.
    c. Close the supply, return and exhaust dampers and seal duct openings in areas subject to construction dust.
2. Source Control
    a. How will reduction of contaminants be reduced at the source?
    b. What steps will be taken to employ low emitting products and sealants.
    c. How will air handling equipment be cycled off when not needed?
3. Pathway Interruption
    a. Describe how the construction space will be ventilated as required to dilute contaminants.
    b. Describe how occupied spaces adjacent to construction areas will be kept at positive pressure relative to spaces under construction.
4. Housekeeping: Describe how the following housekeeping objectives will be implemented:
    a. Reduction of dust generated by work will be suppressed.

b. Maintaining a frequent cleaning frequency for dust and particulates.
c. Remove spills or excess applications of solvent-containing products as soon as possible.
d. Remove accumulated water and keep work areas as dry as possible.
e. Protect insulation materials from exposure to moisture.

5. Scheduling: Describe how overlap of construction activity and ongoing building occupancy activities will be minimized.

F. Field Manual: Submit one copy of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Maintain a second copy on the project site.

G. Any ductwork installed without prior approval by the specifier, shall be replaced at the expense of the contractor.

H. The contractor must comply with the enclosed specification in its entirety. If on inspections, the specifier finds changes have been made without prior approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.

I. At the discretion of the specifier, sheet metal gauges and reinforcing may be checked at various times to verify all duct construction is compliant.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components. Remove damaged products from project site.

1.08 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 DUCTWORK

A. Construct all ducts and plenum of gauges, and with joints, bracing, reinforcing, and other construction details in accordance with the latest construction standards previously listed. Metals shall be manufactured by United States Steel, Nucor or equal.

B. Duct dimensions indicated on drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.

C. Ducts shall be constructed of material gauges and reinforcement Class per SMACNA pressurization classifications to meet 150% of the pressure requirements for external static pressure scheduled on drawings for the fans serving each system. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the code or standard. Refer to Part III - Execution for matrix of pressure and leakage requirements.

D. Ductwork gauge shall not be thinner than 26-gauge for all work.

2.02 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G60 (Z180) for ductwork inside the building envelope in non-corrosive environments. G90 (Z275) for ductwork installed external to the building and may be installed inside the building as an alternate to G60.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.03 DUCTWORK FABRICATION

A. Rectangular Ducts
   1. Longitudinal Seams:
      a. Grooved seam flat/pipe lock (L-3), standing seam (L-4), single corner seam (L-5) or butt/corner weld for +/- 10 in. w.g. service. Snaplock and button-lock (L-1 and L-2) type joints are only allowed when ductwork is installed inside the conditioned space and when duct static pressures are less than 2" w.c. (500 Pa) or these type of joints must be reinforced with screws, soldering or welding when located in unconditioned areas or outside the insulated envelope.
   2. Lateral Joints:
      a. Slip drive joints, standard seams, flanges or welding as required by SMACNA HVAC Duct Construction Standards for system static pressure and sealed airtight. Flanged and gasketed joint fittings, such as Ductmate 25/35/45, Carlisle, MEZ Industries, or equal, are acceptable joint methods, but must be sealed as described previously. Transverse duct joints shall be constructed per Figure 1-4 for types T-8 through T-25. T-1 and T-5 slip joints are NOT allowed for transverse duct joints. T-5 slip joints may be used at connections to fire and smoke dampers as breakaway connections. Joint T-2, T-3, T-6 and T-7 reinforced slip joints are allowed below 2" static pressures.
      b. Exposed Ductwork: All sealant or gaskets applied internally within joint.
      c. Concealed Ductwork: Same as exposed ductwork, or sealant may be applied to the exterior side of joints.
      d. Welded where required for leakproof and airtight operation and per code.

B. Round Ducts
   1. Longitudinal Seams:
      a. Spiral seam (RL-1), butt weld (RL-4), or grooved seam flat/pipe lock (RL-5) for +/- 10 in. w.g. service.
   2. Lateral Joints:
      a. Exposed Ductwork: Beaded sleeve joint (RT-1), crimp joint bead (RT-5), or flange type joint. All joints secured with sheet metal screws. All sealant applied internally within joint.
      b. Concealed Ductwork: Same as exposed ductwork, or sealant may be applied to the exterior side of joints.
      c. Welded where required for leakproof and airtight operation.

C. Elbows
   1. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces, or as shown. For rectangular ductwork provide single thickness turning vanes on all short rectangular elbows less than 25" wide or provide double thickness turning vanes for short rectangular elbows 25" wide and greater. Number of vanes per SMACNA. Elbows with square throat and radius heel are NOT allowed.

D. Transitions
1. Construct transitions to not exceed the slopes identified per SMACNA HVAC Duct Construction Standards-Metal and Flexible. Slopes shall generally be no greater than 15%, and no greater than 30% where shown on the drawings.

E. Branch Connections
1. Provide 45°entry boots or radius taps for rectangular duct take-offs. Provide conical, bellmouth or 45° lo-loss boot taps for round duct take-offs. Straight 90° taps and spin-in taps are not allowed, except where round take-off duct size equals height of branch duct size. Provide volume dampers at each duct take-off for balancing. Provide insulation guards at transitions to lined ductwork.

F. Manufactured Joints
1. 316 stainless steel adjustable clamps with gaskets for connecting welded laterals, branches, and Y fittings. Manufacturer: CECO Environmental #KB Duct or equal.

2.04 RECTANGULAR DUCTWORK

A. Construct rectangular ductwork to meet all functional criteria defined in of the SMACNA HVAC Duct Construction Standards-Metal and Flexible. All ductwork must comply with all local, code requirements. Ductwork shall be constructed of galvanized steel. Diagonally cross break all panels on ducts 30 inches wide and larger, or bead using automatic bead machine with beads at 12 inches on center or less. All connections shall utilize 45° boot take-offs. Bullhead tees and straight taps are not permitted.
1. Listed manufactured ductwork system are allowed where they are installed per the manufacturer’s installation instructions and meet or exceed the requirements of the design requirements.

2.05 ROUND AND OVAL DUCTWORK

A. Round and oval ductwork shall be constructed to SMACNA round ductwork requirements of galvanized sheet steel. Comply with SMACNA HVAC Duct Construction Standards-Metal and Flexible, based on indicated static-pressure class unless otherwise indicated. Longitudinal seams shall be spiral lock seams or continuous welded. Flat oval may be utilized in space-restricted areas. All elbows shall be long radius type with centerline radius to duct diameter of 1.5, exceptions will only be allowed at restricted space locations.

B. Round or oval duct and fitting manufacturers:
1. McGill Airflow Corporation.
2. Lindab.
3. Semco.
4. Sheet Metal Connectors.
5. Spiral Manufacturing.
6. Nordfab.
7. Spiral Fittings.

8. Or equal.

C. Flat-Oval Ducts:
1. Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints:
1. Fabricate according to SMACNA HVAC Duct Construction Standards-Metal and Flexible, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions. All transverse joints, including mechanical flange type fittings, to be externally sealed at all joints.
2. Exception: internal manufactured single or dual EPDM rubber gasket fittings do not require external sealant.
3. Transverse joints in ducts larger than 50” diameter require flanged joints.
4. Lap or snap lock seams are not permitted for round ductwork of any size.

E. Longitudinal Seams:
1. Select seam types and fabricate according to SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA HVAC Duct Construction Standards-Metal and Flexible. All longitudinal joints shall be sealed airtight with sealant or continuous welding.
2. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
3. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals:
1. Select types and fabricate compliant with SMACNA HVAC Duct Construction Standards-Metal and Flexible, Figure 3-5, "45 Degree Tees and Laterals”, and Figure 3-6, "Conical Tees” and “45 Degree Boot Tees" for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions.
2. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted.

G. Elbows:
1. Any deviation from a straight run shall be made using a gored or welded elbows or stamped elbows. Normal 90-degree elbows may include 5-gore fittings and the radius of the elbow is 1.5 times the diameter of the fabric duct. All gores shall be continuous metal or use fully welded joints/seams. Die stamped sheet metal elbows shall be fully welded on the heel and throat by an automated welder. Flexible duct elbows or adjustable gore type elbows are not allowed.
2. Construct long radius elbows with centerline not less than 1.5 times the duct width. Shorter radius elbows may be used where required to fit in restricted spaces with prior approval or where shown on the drawings.

2.06 DIFFUSERS, GRILLES AND REGISTERS

A. All diffusers, grilles, and registers shall be selected to provide proper air distribution for the intended occupant application. All supply air devices shall be selected to provide a maximum air velocity of 50 fpm at three feet above the floor, unless otherwise noted. Manufacturer's representative shall carefully review Architectural and Mechanical drawings and ensure diffuser/grille/register selections will provide proper air distribution at NC 25 or less. Manufacturer at no additional expense to the Owner shall replace diffusers, grilles, and registers not providing proper distribution or excessive noise at scheduled airflow.

B. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper where individual duct mounted balancing dampers are not provided.

C. Refer to schedule on drawings for sizes, capacities and patterns.

D. Manufacturers: Titus, Krueger, Price, Metal Aire, Nailor, Anemostat, Carnes, Tuttle&Bailey, or equal.

2.07 FLEXIBLE DUCTWORK

A. Pre-insulated flexible round ductwork, minimum one-inch thick, Class 0 or Class 1, may be utilized for final connections to each air outlet and inlet, unless shown otherwise on the plans. Uninsulated flexible ductwork, flexible PVC or flexible aluminum duct products are not allowed. Duct shall have a minimum R-4.2 (one-inch thick) for ductwork enclosed in conditioned spaces and R-8.0 (two-inch thick) for ductwork installed in unconditioned spaces. Maximum length of flexible ductwork in each low-pressure branch shall not exceed five feet (5’) and maximum flexible connector lengths shall not exceed five feet (5’).

B. All connections shall utilize welded conical tees, aluminum conical fitting, or manufacturer high efficiency branch take-offs. Spin-in type or other types of butt tees, bullhead tees or straight taps ARE NOT permitted. Manufacturers: Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STO, or equal.

C. Dampers regulators shall include end bearings as manufactured by DuraDyne, Ventlok or equal.

D. Flexible ductwork for low pressure systems with positive static pressure up to 2” w.g. positive pressure and negative pressured up to 1/2" w.g. suitable for both terminal unit connection and diffuser/grilles. Flexible ductwork fittings may be used at seismic expansion joints and to accommodate vertical drift between building levels. Fabrication shall include a multiple laminate of aluminized polyester/mylar, fiberglass insulation, and polyester, mechanically locked to galvanized steel helix without adhesives, exterior

fiberglass insulation and fire-retardant polyester/mylar outer jacket. Manufacturers: Casco #L-181M, Flexmaster #Type 5B, Thermaflex #M-KC or EverClean, or equal.

E. Flexible Duct Clamps/Draw Bands: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes up to 18 inches to match duct size. Use permanent screwed attachment systems for ducts sizes larger than 18”.

2.08 DUCTWORK SPECIALTIES

A. General: Where specifically called for, materials for use in fabricating ductwork specialties shall be identical to that used to fabricate ductwork. See drawings and Part 3, Execution for schedule.

B. Flexible Connections (Indoor Applications):
1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
2. Neoprene (polychloroprene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame. Hypalon, teflon or silicone coated fabrics may be acceptable.
3. Shall be airtight, watertight and fire retardant.
4. Minimum density of 30 oz. per sq. yard.
5. Temperature range: -40°F to 200°F
6. Neoprene-only connectors are not allowed due to non-compliant surface-burning characteristics.
7. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal up to maximum dimensions of 4” metal, 6” fabric, 4” metal as required by application.
8. Manufacturers: Ventfabrics #Ventglas, Duro Dyne, Q Industries, Kinetics, Ductmate Proflex or Elgen.

C. Flexible Connections (Outdoor Applications):
1. Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation.
2. Hypalon (chlorosulfurated polyethylene) impregnated glass cloth with 24-gauge (minimum) galvanized metal frame.
3. Shall be airtight, watertight and fire retardant. Resistant to sunlight, ozone and weather.
4. Minimum density of 26 oz. per sq. yard.
5. Temperature range: -50°F to 275°F
7. Minimum dimensions shall be 3" metal, 3" fabric, 3" metal up to maximum dimensions of 4” metal, 6” fabric, 4” metal as required by application.
8. Provide flexible cloth insulating blanket to encase flexible connections to maintain ductwork insulation integrity as follows:
   a. Jacket shall be UV and ozone resistant with Velcro attachment.
   b. Service Operating Temperature: 0-350°F.

c. Jacket and Liner: silicon or teflon impregnated fiberglass or mineral wool cloth.
d. Insulation: Aerogel, 2” thick (minimum) or R-8 equivalent (minimum), and thicker as required by local energy code.
e. Fastening: 2” Nomex Velcro or 1” straps and stainless steel D-rings.
f. Thread: Kevlar/stainless steel thread.
g. Manufacturers: Thermal Energy Products, Coverflex, Thermaxx, Pacor, Unitherm, Advance Thermal, Fit Tight Covers, or equal.

9. Manufacturers: Ventfabrics #Ventlon, Duro Dyne, Kinetics, Ductmate Proflex or Elgen.

D. Volume and Splitter Dampers: Galvanized sheet metal blade and frame with Ventfabrics Inc., Ventlok operating hardware. For accessible dampers, provide #641 self -locking dial regulators and #644 self-locking dial regulators for insulated ductwork, #637 square end bearing, and #635 spring end bearing, as applicable. For inaccessible dampers, provide #666 or #677 concealed locking damper regulator with bearings as above. For static pressures above 3"wg, provide #640 HiVel dial regulator and #609 HiVel end bearing for accessible dampers. Regulators shall extend to and through ceiling with neatly installed hardware at the finished ceiling. For inaccessible dampers requiring adjustment through diffusers use Young Regulator, Bowden cable control system.

E. Multi-louver Volume Dampers: 16-gauge galvanized steel frame. Opposed, 6" wide, 16-gauge galvanized steel blades. Concealed linkage in frame. Ruskin #CD35/OBD or equal.

F. Ducts Through Roof: Unsupported duct penetration through a roof, without roof curbs, shall be 16-gauge (minimum), flashed and counterflashed, and provided with storm collars to secure a watertight construction.

G. Bird/Insect Screens: 19-gauge (0.91 mm) galvanized after weld wire mesh (minimum gauge), 1/2" x 1/2” openings (maximum) set in a galvanized steel frame. Or, 23-gauge (0.57 mm) galvanized after weld wire mesh (maximum gauge), 3/8" x 3/8” openings (minimum) set in a galvanized steel frame. Verify minimum requirements per local code for outdoor air intake and exhaust outlets.

H. Seismic Duct Connector (Indoors): Provide flexible connector at penetrations between two structural elements where the structural design has designated allowable seismic or settlement movement. Flexible EPDM elastomeric fabric bonded to a 1/4" steel perimeter flange on each end. EPDM shall be rated for maximum temperature of 250°F and 3 psi maximum. Connector shall be rated to meet or exceed structural design requirements with a minimum of 3” for axial compression, 3” axial extension, and 3” lateral deflection. Manufacturers: Mercer Rubber Co #ME-3/MI-9-3, Mason Industries #MD-4/MI-9, Flexicraft, Garlock, Hyspan, or equal.

I. Hanging Cables with Adjustable Fastener: Wire rope hangers for maximum point loads not exceeding 100 lbs. (45 Kg) for supporting rigid galvanized ductwork not exceeding

18” (450 mm) diameter, and suspended diffusers/grilles/terminal units. Alternate to metal strap options per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1. Wire Rope: High tensile steel wire rope, to ASTM 1023/1023M, class A zinc coating; 7 by 7 or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi (1,770 N per sq. mm); lengths, diameters, and wire construction to accommodate design loads and as indicated on Construction Shop Drawings.
2. Adjustable Fastener: Mild steel (type EN1A), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 100 lbs. (45 kg) (maximum per hanger).
3. Manufacturers: Gripple #Standard No. 2/3/4/5, Ductmate #Clutcher, or equal.

2.09 ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct." Access doors shall be insulated hollow core double construction. Access doors in exhaust ducts shall be of same, or heavier, gauge material as duct in which installed.

B. Casing Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 9-16, "Casing Access Doors." Access doors shall be insulated hollow core double construction of same, or heavier, gauge material as duct in which installed.

C. Minimum door size shall be 12" by 12" for simple manual access and up to 24" by 24" where personnel must pass through infrequently. Provide 20" x 54" (minimum) door for access to filters and more frequent maintenance.

D. Maximum door leakage shall not exceed 10 cfm/sq.ft. at maximum operating pressure. Doors larger than four sq.ft. in area shall open against pressure.

E. Doors:
   1. Double wall, rectangular.
   2. Galvanized sheet metal with insulation fill and gauge thickness as indicated for duct pressure class. Minimum 1” insulation thickness for doors up to 24” tall and 2” thick insulation for larger door assemblies as required per energy code. Insulation not required in exhaust duct access doors as allowed by local code.
   3. Latches: Steel cam or lever type. Access doors shall openable by hand with no tools.
   4. Vision panel shall be provided on doors 24” x 60” and larger.
   5. Fabricate doors airtight and suitable for duct pressure and air leakage class.
   6. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets for doors up to 24” tall. For larger doors provide 1-1/2" by 1/8" flat stock or 14-gauge angle frame.

7. Gaskets: Closed cell neoprene rubber, 1” x 1/4" (minimum).
8. Access Door Manufacturers (Small Dimensions, Low Pressure Rating): CESCO, Pottorff, Ruskin, Vent Products, Air Balance Inc., Ductmate Sandwich, United Enertech, or equal, as required by size and pressure application.

F. Hinges and Latches:
1. Access doors up to 14 by 14 inches (300 x 300 mm) square: Two hinges or continuous piano hinge and one sash lock. Doors shall not be removable.
2. Access doors up to 16 by 24 inches (400 by 600 mm) square: Two hinges or continuous piano hinge and two sash locks (minimum). Doors shall not be removable.
3. Access doors up to 24 by 48 inches (600 by 1200 mm): Three hinges or continuous piano hinge and two compression latches (minimum) with outside and inside handles.
4. Access doors larger than 24 by 48 inches (600 by 1200 mm): Four hinges or continuous piano hinge and two compression latches (minimum) with outside and inside handles.
5. Latch Manufacturer: Ventlok #100 Series hinges and latches on low pressure system doors up to 18 " maximum dimension, #200 Series on larger low pressure system doors, #333 Series on high pressure systems with stops, or equal.

2.10 DUCTWORK SEALANT

A. Duct tape, pressure sensitive type, is not allowed.

B. Solvent-based and oil-based sealants are not allowed indoors.

C. Seal all transverse joints, including mechanical joint flanges, similar to Ductmate, on all supply, return, exhaust, and outside air intake ducts.

D. All sealant systems for outdoor application to be suitable for use in exposure to water, sunlight, temperatures extremes associated with project location.

E. All sealant systems for indoor application to be meet VOC limits as specified in South Coast Air Quality Management District (SCAQMD) Rule #1168 limiting VOC’s to 80 grams/liter for duct liner adhesives and 250 grams/liter for duct sealants.

F. Indoor Application Water-Based Joint and Seam Sealant:
1. Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
   a. Sealant shall be water based latex UL 181 B-M non-reinforced sealant.
   b. Sealant shall meet flame spread rating of 0 and smoke developed rating of 0.
   c. Flexibility on 1/4” mandrel.
   d. Freeze/thaw stability - 5 cycles.
   e. Service temperature: -20°F to +200°F (-29°F to +93°C).

f. ASTM 5590; Resistance to mold, mildew and water.
g. Meet all SMACNA seal classes.
h. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6, and 10" water gauge.

2. Manufacturer: Carlisle (Hardcast) #Iron Grip 601 or #Flex-Grip 550 or #Spray-Seal, Ductmate #PROseal, Design Polymerics #DP1010 or #DP1020 or #DP 1010 Spray, or equal.

G. Indoor Application Water-Based Joint and Seam Sealant with Extended Material Warranty:

1. Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.
   a. Sealant shall be water based latex UL 181 B-M non-reinforced sealant.
   b. Sealant shall meet flame spread rating of 0 and smoke developed rating of 0.
   c. Flexibility on 1/4" mandrel.
   d. Freeze/thaw stability - 5 cycles.
   e. Service temperature: -20°F to +200°F (-29°F to +93°C).
   f. ASTM 5590; Resistance to mold, mildew and water.
   g. Meet all SMACNA seal classes.
   h. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6, and 10" water gauge.
   i. Manufacturer: Carlisle (Hardcast) #Iron Grip 601 or #Flex-Grip 550 or #Spray-Seal and #Aluma-Grip AFT-701 rolled sealant, or equal.
2. And, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed by a 30-mil rolled sealant. Rolled sealant shall be comprised of a 2-mil foil faced with 28 mils of butyl adhesive/sealant conforming to the product specifications. Rolled sealant shall have the following physical properties:
   a. Peel Strength: 16 lbs. per linear inch.
   b. Tensile strength: 955 psi
   c. Elongation: 560%
   d. Bonding time: Instant with full bond in 24 hours.
   e. Resistance to mold, mildew and water.
   f. Weather Resistance per ASTM G-53 @ 2000 hours QUV.
   g. Service temperature: -20°F to +200°F (-29°F to +93°C).
   h. Surface burning characteristics: Flame spread/smoke developed rating of 20/40, tested in accordance with UL 723.
   i. VOC: 0 g/l
   j. Meet all SMACNA seal classes.
   k. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, and 6" water gauge.
   l. Manufacturer: Carlisle (Hardcast) #Aluma-Grip AFT-701 rolled sealant, or equal.

H. Outdoor Application Two-Part Tape Sealing System:

1. Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermally with tape to form hard, durable airtight seal.
2. Manufacturer: Carlisle (Hardcast) #Two Part II, McGill Uni-Cast, or equal.

I. Outdoor Application Low VOC Solvent Based Joint and Seam Sealant:
1. Flexible, adhesive sealant, suitable for outdoor application on joints and seams.
   a. Sealant shall be solvent based synthetic elastomeric. Water and UV resistant. Crack and peel resistant.
   b. Compliant with ASMT E84 and UL 723. Sealant shall meet flame spread rating of 0 and smoke developed rating of 0 after cured.
   c. Freeze/thaw stability - 5 cycles.
   d. Service temperature: -20°F to +190°F (-29°C to +88°C).
   e. VOC: 44 g/l.
   f. ASTM 5590 compliant for resistance to mold, mildew and water.
   g. Meet all SMACNA seal classes.
   h. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6, and 10” water gauge.
2. Manufacturer: Design Polymerics #DP1090 or equal.

J. Rolled (Tape) Mastic Sealant for indoor and outdoor application on flat sheet metal duct joints. Aluminum substrate with modified butyl sealant. Compliant with UL 181B-FX. Rolled sealant shall have the following physical properties:
1. Peel Strength: >10 lbs. per linear inch.
2. Bonding time: Instant tack with full bond in 24 hours.
3. Resistance to mold, mildew and water.
4. Weather Resistance per ASTM G-53 @ 2000 hours QUV.
5. Service temperature: -20°F to +180°F (-29°C to +82°C).
6. Surface burning characteristics: Flame spread/smoke developed rating of 5/25, tested in accordance with UL 723.
7. VOC: 0 g/l.
8. Meet all SMACNA seal classes.
9. Meet all SMACNA pressure classes (+/-): 1/2, 1, 2, 3, 4, 6” and 10” water gauge.
10. Roll width as required to maintain minimum 3/4” adhesion width on each side of joint.
11. City of Los Angeles RR#8069 approved.
12. Manufacturer: Carlisle (Hardcast) #Foil-Grip 1404-181BFX rolled sealant, or equal.

K. Manufacturers of duct sealant systems for various ductwork applications: Design Polymerics, Tremco, Dure Dyne, Carlisle Hardcast, Ductmate, Mon-Eco Industries, Sikaflex, and McGill AirSeal LLC.

2.11 PRE-INSULATED DUCT SYSTEM FOR OUTDOOR AND UNCONDITIONED LOCATIONS

A. General
1. Pre-manufactured exterior ductwork to be a double layered duct system using the Pal Phenolic duct panels pre-fabricated and assembled into inter-locking sections. This as an alternate method to contractor fabricated double wall sheet metal ductwork with internal insulation.
2. All fabricated duct segments and fittings shall be designed in accordance with "SMACNA HVAC Phenolic Duct Construction Standards" latest edition.
3. Duct sizes are limited to maximum 80" x 80" operating up to 4" w.g. positive or 3" w.g. negative pressure class.

B. System
1. The panels used in the fabrication of the ductwork system shall Pal Phenolic Duct rigid phenolic insulation panels with a thermal conductivity of 0.1977 BTU-in/hr•ft^2 °F and a minimum compressive strength of 29 psi, as manufactured by Pal International.
2. Assembled panels shall be a minimum of 2" thick and minimum R-10 insulating value.
3. Pal Phenolic Duct rigid phenolic insulation panels shall comprise a 3.4–3.75 pcf nominal density CFC/HCFC–free rigid Phenolic insulation core with zero Ozone Depletion Potential (ODP), autohesively bonded on both sides with 60-micron aluminum internal liner and a 200-micron aluminum external liner. Both liners are to be solid aluminum with no perforations.
4. All other components required for the fabrication of the system shall be from the Pal Phenolic Duct System guidelines including the sealant, contact adhesive, aluminum tape, self–adhesive gasket, ductwork reinforcements, closures, connectors and flanges.
5. Exterior weatherproof cladding shall be a 5 ply, zero permeability vapor barrier, puncture resistant, tear resistant, flexible, and meet UL-1709.

C. Fire and Smoke Performance
1. The rigid phenolic insulation panels shall achieve the following fire and smoke performance requirements:
    a. ASTM E 84–low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices.
    b. UL 723 –low contribution to fire growth not exceeding 25 Flame Spread and 50 Smoke Developed indices.
    c. UL 181 – UL/ULC classification as a Class 1 Air Duct to NFPA Standards 90A & 90B.

D. Sealant Material
1. All internal seams must be fully sealed with an unbroken layer of Pal Phenolic sealant.
2. Each ductwork section must be duly connected with an inter-locking, double sealed jointing system. Sufficient sealant should be applied to each layer in

order to seal the rigid phenolic insulation panels and ensure minimum air leakage.

3. Ductwork reinforcement, if necessary, shall be applied to protect against side deformation from both positive and negative pressure.
4. All external seams where two separate panels join must be tiger clipped, taped and jacketed in watershed fashion whenever possible to achieve a permanent bond with weather protection and a smooth appearance.

E. Manufacturers: AQC Industries #QDuct, KoolDuct or equal.

2.12 FIBERGLASS DUCTBOARD

A. Ductboard shall be 1" thick (minimum) finished with a factory-applied thermosetting acrylic polymer coating to the air stream side resistant to potential dust incursion into the material substrate, containing an immobilized EPA-approved anti-microbial agent to further inhibit potential microbial growth as indicated by ASTM G-21 and G-22 test data and resistant to fiber shed and damage during duct cleaning operations.

B. Reinforce as necessary to assure no collapse of ducts under positive or negative pressures up to 1.0" w.g. of static pressure. Support ductwork with 3/4" wide galvanized sheet metal straps at intervals recommended by manufacturer. Protect duct wall against abrasion from support straps. Support at all fittings and each change in direction.

C. Product requirements:
1. Fiber glass duct board with a bio based thermosetting resin meeting.
2. Comply with ASTM C411, ASTM C1071, ASTM E84, UL723, and UL Greenguard Low VOC certified.
3. Comply with ASTM G21 and ASTM G22 and ASTM C1338 for microbial resistance.
4. K-value: 0.23 Btu•in./(hr•ft²•ºF) at 75°F (maximum).
5. Water vapor absorption: ASTM C1104, less than 3% by weight.
6. Noise Reduction Coefficient (NRC) equal to, or greater than, 0.75 based on ASTM C423 Type “A” mounting.
7. Maximum allowable velocity on mat or coated air side: 1,000 ft./min.
8. Surface burning: NFPA 90 A and 90B.
9. Maximum operating temperature: 250°F.
10. Flame spread index: ASTM E84, less than 25.
11. Smoke developed index: ASTM E84, less than 50.
12. Density: 3.0 lbs./cu ft. (minimum).
13. Vapor Barrier Jacket: ASJ+ (All Service Jacket) or FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with glass mineral wool yarn and laminated to fire-resistant Kraft paper.

D. Duct board must be fabricated and installed in accordance with the NAIMA or SMACNA Fibrous Glass Duct Construction Standards and all closure systems must meet the requirements of UL 181A.

E. Manufacturers: Johns Manville #Superduct RC, Certainteed #Ultra*Duct or equal.

2.13 PLENUMS AND EQUIPMENT CASINGS

A. Construct casings and plenums in conformance with SMACNA. Minimum Pressure Class: Unless otherwise indicated construct plenums and casings to withstand either a negative or positive static pressure of 4" w.g.

B. Single-Wall: Provide single-wall, casings and plenums where indicated on the drawings.
1. Construct in accordance with SMACNA Standards.
2. Use steel-angle-reinforced standing-seam construction.
3. Locate intermediate bracing angles bolted to the casing 24 inches on centers.
4. Construct for static pressure indicated or for the maximum fan static pressure whichever is less.
5. Bolt to 3" high concrete pads using 1-1/2" x 1-1/2" x 1/4" thick galvanized steel structural sections.

C. Double-Wall: Provide double-wall insulated ductwork where indicated on the drawings.
1. Construct in accordance with SMACNA Standards. Provide insulation thicknesses to meet or exceed the minimum required by local energy codes.
2. Provide 2" (minimum) thick prefabricated double wall insulated metal panel assemblies, with 16-gauge aluminum or 18-gauge minimum galvanized steel outer sheets.
3. Provide 22-gauge galvanized steel inner sheets to encapsulate the insulation.
4. Casings shall be fully metal enclosed, insulated with 2" thick (minimum) rigid fiberglass insulation and conforming to NFPA 90A, with maximum flame spread of 25 and maximum smoke developed of 50.
5. Field or factory fabricate to size and configuration indicated on the drawings, using field verified dimensions.
6. Provide coordinated shop drawings.
7. Reinforce spans 10' or greater with structural steel sections to yield maximum deflection 1/4" at minus 10" w.g. or plus 10" w.g. static pressure.
8. Provide openings and doors, all factory framed, and reinforced with 304 stainless steel structural sections.
9. Construct doors of same material as casings, of sizes and locations indicated on the drawings but not smaller than 18" by 54", and conforming to SMACNA.
10. Provide doors, hinges and hardware factory fabricated and mounted.
11. Door swings shall open against air pressure, with door latches operable from either side.
12. Provide door seals with neoprene gaskets, which have an airtight seal.
13. Provide each door with a 10" by 10" wire reinforced double pane window.
14. Bolt base channel to 3" high concrete pads.

2.14 CONTROL DAMPERS

A. General: Low leakage dampers shall be Class 1A with a maximum leakage rate of 3 cfm/ft^2 at 1.0 in wg pressure difference when tested to AMCA Standard 500.

B. Damper Type One: Airfoil Low Leakage Dampers (Galvanized Steel or Aluminum)
   1. Application: Commercial supply, return, and general exhaust air systems up to 3,000 fpm velocity. Damper shall be rated for -22°F to 122°F (-30°C to 50°C) minimum operating range.
   2. Frames to be 5" x 1"x 16-gauge galvanized steel hat-shaped channel or 5" x 1" x 0.125 anodized extruded aluminum hat channel with corner reinforcement.
   3. Blades: Airfoil shaped, single piece, 6" wide (maximum), 14-gauge galvanized steel or 6063-T5 anodized aluminum.
      a. Action:
         1) Parallel blade for open and closed control, and economizer dampers.
         2) Opposed blade for modulating and air flow measurement control.
   4. Seals: Silicone rubber or EPDM blade and jam seals.
   5. Axles: 7/16" diameter steel (minimum), hex-shaped, mechanically attached to blade.
   6. Bearings: Self-lubricating stainless steel or molded synthetic sleeve.
   7. Linkage to be concealed in frame.
   8. Crank lever for operator to be provided.
   9. Provide with mill finish on blades and frame.
   10. Damper position indicator switch(es) as required by control sequence.
   11. Manufacturer: Ruskin #CD60 or #CD50, Swartout, NCA PBD/OPD-AF-101, American Warming, Tamco, Air Balance, Greenheck, Pottorff, Nailor or equal.

C. Damper Type Two: Airfoil Low Leakage for Coastal and High Moisture Environments (Aluminum)
   1. Application: Commercial supply, return, and general exhaust air systems where damper will be exposed to damp marine air and where velocity is less than 3,000 fpm. Damper shall be rated for -22°F to 122°F (-30°C to 50°C) minimum operating range.
   2. Frame to be 5" x 1" x 0.125 anodized extruded aluminum hat channel with silicon side seals and corner reinforcement.
   3. Blades: Airfoil shaped, single piece, 6" wide (maximum), 6063-T5 anodized aluminum.
      a. Action:
         1) Parallel blade for open and closed control, and economizer dampers.
         2) Opposed blade for modulating and air flow measurement control.
   4. Seals: Silicone rubber or EPDM blade and jam seals.
   5. Axles: 1/2" diameter steel, hex-shaped, mechanically attached to blade.
   6. Bearings: Self-lubricating stainless steel sleeve or molded synthetic sleeve.
   7. Linkage to be concealed in frame.
   8. Stainless steel hardware.
   9. Damper position indicator switch(es) as required by control sequence.

10. Manufacturer: Tamco #SW Series, Ruskin #CD50, Swartout, NCA, Pottorff, American Warming, Air Balance, Greenheck or equal.

D. Damper Type Three: Heavy Duty Fan Discharge Control
1. Application: Velocity over 3,000 fpm as fan outlet damper.
2. Frames to be 8" x 2" x 12-gauge steel channel (minimum).
3. Blades to be 8" wide (maximum), 0.080 thick extruded aluminum airfoil design.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 3/4" diameter steel, hex-shaped, mechanically attached to blade.
6. Bearings: Stainless steel sleeve type pressed into frame.
7. Linkage to be out of airstream with 10-gauge galvanized steel clevis type arms with crank lever operator.
8. Provide with mill finish on blades and frame.
9. Maximum temperature rating to be 300°F.
10. Manufacturer: Ruskin #CD102, Nailor, Swartout, Pottorff, American Warming, Air Balance, Greenheck or equal.

E. Damper Type Four: Low Leakage Airfoil Insulated Dampers
1. Application: Air handler intake and exhaust. Damper shall be rated for -25°F to 180°F (-32°C to 83°C) minimum operating range.
2. Frames to be 5" x 1"x 16-gauge galvanized steel hat-shaped channel or 5" x 1" x 0.125 anodized extruded aluminum hat channel with corner reinforcement.
3. Blades: Insulated, single piece, 6" wide (maximum), 14-gauge galvanized steel or 6063-T5 anodized aluminum, R-3.3.
   a. Action: Parallel blade for open and closed control.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 7/16" diameter steel (minimum), hex-shaped, mechanically attached to blade.
6. Bearings: Self-lubricating stainless steel or molded synthetic sleeve.
7. Linkage to be concealed in frame.
8. Crank lever for operator to be provided.
9. Provide with mill finish on blades and frame.
10. Damper position indicator switch(es) as required by control sequence.
11. Manufacturer: Ruskin #IL35, Greenheck, Pottorff, Tamco, or equal.

F. Damper Type Five: Ultra Low Leakage Airfoil, Double Row Dampers
1. Application: Natural ventilation wall inlets and outlets with parallel (double row) damper blades. Damper shall be rated for -72°F to 275°F (-58°C to 135°C) minimum operating range.
2. Frames to be 8” x 1” steel or aluminum channel thermally broken with insulation within frame channels.
3. Blades: Airfoil shaped, single piece, 4" wide (maximum), 14-gauge galvanized steel or 6063-T5 anodized aluminum.
   a. Action: Parallel blade for open and closed control.
4. Seals: Silicone rubber or EPDM blade and jam seals.
5. Axles: 7/16" diameter steel (minimum), hex-shaped, mechanically attached to blade.

6. Bearings: Self-lubricating stainless steel or molded synthetic sleeve.
7. Linkage to be concealed in frame
8. Crank lever for operator to be provided.
9. Provide with mill finish on blades and frame.
10. Damper position indicator switch(es) as required by control sequence.
11. Manufacturer: Ruskin #CD40x2, Greenheck, Pottorff, Tamco, or equal.

2.15 BACKDRAFT AND RELIEF DAMPERS

A. Light Duty Counterbalanced Backdraft Damper
1. Applications: Low pressure ductwork systems, including outside air intake and exhaust locations.
2. Frame: Extruded aluminum channel frame with flanges to match ductwork requirements.
3. Blades: Parallel blades, horizontal orientation, 0.025” (0.6 mm) minimum formed aluminum. Maximum 6” wide blades. Extruded vinyl blade seals mechanically attached to blade edge.
4. Counterbalance: Adjustable steel weights mechanically attached to blade.
5. Mounting: Vertically or horizontally oriented as shown on the drawings.
6. Sized for maximum velocity of 1,500 fpm (7.6 m/s).
7. Maximum back pressure of 2.0” w.g. (1.1 kPa).
8. Maximum Pressure Drop Fully Open: 0.06” w.g. (15 Pa).
9. Manufacturer: Ruskin #CBD2, Greenheck #WD Series, or equal.

B. Heavy Duty Counterbalanced Backdraft Damper
1. Application: Medium pressure air ductwork and generator exhaust.
2. Frame: Galvanized steel, 16-gauge (1.5 mm) wall thickness minimum with flanges to match ductwork requirements.
3. Blades: Parallel blades, horizontal orientation, 0.05” (1.2 mm) minimum formed aluminum. Maximum 6” wide blades. Extruded vinyl blade seals mechanically attached to blade edge.
4. Counterbalance: Adjustable steel weights mechanically attached to blade.
5. Mounting: Vertically or horizontally oriented as shown on the drawings.
6. Sized for maximum velocity of 2,500 fpm (12.7 m/s).
7. Maximum back pressure of 4.5” w.g. (1.1 kPa).
8. Maximum Pressure Drop Fully Open: 0.20” w.g. (50 Pa).
9. Manufacturer: Ruskin #BD6, Greenheck #HB Series, Nailor #1380, or equal.

C. Barometric Relief Damper
1. Applications: Gravity hood exhaust, room pressurization control and stairwell pressurization relief.
2. Frame: Extruded aluminum channel frame, 0.090” (2.3 mm) wall thickness minimum with flanges to match ductwork requirements.
3. Blades: Parallel blades, horizontal orientation, 0.063” (1.6 mm) minimum formed aluminum. Maximum 6” wide blades. Extruded vinyl blade seals mechanically attached to blade edge.

4. Counterbalance: Adjustable on-blade counterweights for tuning of start-to-open and full open blade operation.
5. Axle: 3/8” (9.5 mm) galvanized steel rod with roller bearings.
6. Mounting: Vertically or horizontally oriented as shown on the drawings.
7. Sized for maximum velocity of 1,000 fpm (5.1 m/s).
8. Maximum back pressure of 2.0” w.g. (0.5 kPa).
9. Start-Open Pressure: 0.05” w.g. (12.5 Pa).
10. Manufacturer: Greenheck #BR-30 for vertical mounting, Greenheck #BD-10 for horizontal mounting, or equal.

D. Round Counterbalanced Backdraft Damper
1. Dampers shall be of the two-blade design with separate axles. Blades shall be retained in closed position with tensioned spring and field adjustable for required opening pressure. Not allowed for installation in dryer exhaust, kitchen exhaust or bypass air applications.
2. Frame: 20-gauge (1.0 mm) minimum galvanized steel.
3. Blade: 0.016” thick (0.40 mm) minimum aluminum.
4. Blade Seals: Vinyl foam.
5. Axle: 3/16” (4.8 mm) minimum steel.
6. Maximum Velocity: 1,000 fpm (7.6 m/s).
7. Maximum Pressure Drop Fully Open: 0.06” w.g. (125 kPA).
8. Manufacturer: Ruskin #BDR2, Greenheck #WDR-53 or equal.

E. Light Duty Non-Counterbalanced Neoprene Backdraft Damper
1. Applications: Low pressure exhaust from small mechanical equipment less than 2,500 cfm.
2. Frame: 16-gauge galvanized steel with flanges to match ductwork requirements.
3. Blades: Neoprene coated fiberglass. Maximum 6” wide blades.
4. Mounting: Vertically or horizontally oriented as shown on the drawings.
5. Sized for maximum velocity of 1,000 fpm (5.1 m/s).
6. Manufacturer: Ruskin #NMW2 or equal.

2.16 LOUVERS

A. Louvers are generally to be provided under Division 8 or as specified in the equipment schedules on the drawings. Where louvers are not covered on architectural plans and specifications, contractor is to provide louvers with the following minimum specifications:
1. Louvers to be 6" deep, 35° drainable fixed blade design, constructed of galvanized steel or extruded aluminum, or as specified on the plans.
2. Frames to be constructed of 6" deep channel, aluminum or galvanized steel.
3. Provide with 1/2" x 1/2" aluminum mesh bird screen mounted on backside of louver.
4. Finish/color per architect/engineer's review of manufacturers color chart or custom color matching if required.
5. Manufacturer: Ruskin #ELF6375DX or equal.

2.17 DUCT SMOKE DETECTORS (DSD)

A. Duct mounted photoelectric smoke detector. One required for each heating or cooling system supplying air in excess of 2,000 cfm, for systems serving more than one occupancy type, and for control of each combination fire/smoke damper when not controlled by Division 26 area wide detection system.

B. Coordinate with Division 26 work and electrical installer for power to smoke detector. Detector shall be installed in the system in compliance with Chapter 6 of the Mechanical Code and NFPA-72. Provide 24-volt power supply option and/or 24-volt transformer as required to coordinate with Division 26.

C. Coordinate with control installer to assure that detector shall shut down the air-moving equipment when smoke is detected and close associated damper actuator(s). Sensor shall be selected to operate with air velocity rating from 100 to 4000 fpm. Provide with metal sampling tube. Provide remote test and reset station at ceiling or as otherwise indicated. Duct smoke detector shall be installed in the supply or return in compliance with the applicable mechanical or building code. Coordinate with Section 230900 and 230593 work.

D. Provide additional duct smoke detectors per requirements of Section 6.4 of NFPA-90A. Provide one duct smoke detector at each story to the connection to a common supply and/or return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 cfm and serving more than one story.

E. Provide additional duct smoke detectors in high rise buildings and I-2 Occupancies per the Section 907.2 of the Building Code with duct smoke detectors in the main return and exhaust air plenums of each air-conditioning system having a capacity greater than 2,000 cfm.

F. Manufacturer: System Sensor #D2 series or equal.

2.18 FIRE, SMOKE AND COMBINATION FIRE/SMOKE DAMPERS

A. General:
1. Provide UL labeled 3 hour rated fire dampers at 3-hour and greater penetrations.
2. Provide UL labeled 1-1/2 hour rated fire dampers at less than 3-hour penetrations.
3. All dampers to be certified under the latest UL Standard. Certification based on former non-current standards is unacceptable.
4. All damper installations to conform with NFPA 90A and manufacturer's installation instructions. Details on drawings are shown for reference only.
5. Install in ducts passing through walls, floors, and ceilings as required by code. Refer to Architectural and Mechanical plans for damper locations.
6. Provide fire, smoke and fire/smoke dampers in locations as required by local code and NFPA-90A and 92A.

7. Provide sleeves, slip joints, retaining angles, duct access doors, ceiling access panels, etc., as required to check and service the fire dampers. Slip or break away joints are not allowed to be taped or sealed.
8. Access doors shall be tight fitting hinged with hand operable cam or lever type latches. Access shall not require the use of keys, tools or special knowledge. Removable doors are not allowed. The access point shall permanently labeled with 1" (25 mm) high letters: "FIRE DAMPER", "SMOKE DAMPER", or "FIRE/SMOKE DAMPER".
9. All dampers to be designed for use in dynamic systems.
10. Dampers shall be rated for Leakage Class I. Leakage Class II may be used if damper size is smaller than available Leakage Class I dampers.
11. Dampers shall be certified for use by State and local authorities.
12. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress doe to twisting, racking, bowing, or other installation error. Do not install actuators in area where moisture can penetrate actuator or where temperature exceeds 120°F.
13. All fire dampers shall be sized to provide equivalent free area through the damper equal to, or greater than, the free area of the connecting ductwork. Upsize fire dampers as required to minimize pressure drops. In no case is the damper pressure drop to exceed 0.20" w.g., but ideally less than 0.10" w.g .for low velocity dampers, as designed for total system static pressure allowance. Refer to submittal requirements in Part One of this section and requirements on the drawings.

B. Radiation Ceiling Fire Dampers:
1. Bladed ceiling fire damper constructed and tested in conformance with UL-555C (dynamic rating).
2. Fire damper shall have a fusible link that opens at 165°F (74°C) or 212°F (100°C) for high temperature duct applications. Installation shall be in accordance with damper manufacturer's instructions.
3. Provide fire blanket where required to obtain listed fire rating.
4. Manufacturers: Ruskin #CFD Series, Greenheck #CRD Series, or equal by Pottorff, Cesco, Nailor, or Air Balance.

C. Dynamic Fire Dampers (FD) for use in Dynamic and Static Systems:
1. Curtain fire damper constructed and tested in conformance with UL-555C.
2. Fire damper shall have a fusible link that opens at 165°F (74°C) or 212°F (100°C) for high temperature duct applications. Fire damper shall be equipped for vertical penetrations with manufacturer supplied sleeve. Installation shall be in accordance with damper manufacturer's instructions.
3. Curtain damper shall not be located in air stream during system operation, Style B or C. Clear inside opening through fire damper is to match clear inside opening of duct. Fire dampers in lined ducts are to match size of sheet metal duct.
4. Dynamic Closure Rating Velocity: 2000 fpm (minimum).

5. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10” w.g. at full air flow.
6. Pressure rating: 4” w.g.
7. Manufacturers: Ruskin #DIBD Series, Greenheck #DFD Series, or equal by Pottorff, Air Balance, Nailor or CESCO.

D. Combination Fire and Smoke Dampers (FSD):
   1. Required Locations:
      a. Install at ducted penetrations through rated fire barriers, fire walls, rated ceilings, rated corridor ceilings, shaft enclosures, and smoke barriers and partitions as defined on Architectural drawings and Chapter 7 of the Building Code.
      b. Per NFPA-90A install smoke dampers or combination fire/smoke dampers in systems with a capacity greater than 15,000 cfm to isolate the air handling equipment from the remainder of the system on the building supply and return side. Air handling units located on the floor they serve and only serving that floor are exempt. Air handling units located on the roof and serving only the floor immediately below the roof shall be exempt.
   2. General Requirements:
      a. Dampers shall be Low Leakage Class 1 in accordance with UL 555S.
      b. Dampers shall be provided as a manufactured UL listed device with electric actuator. Actuator shall be attached to sleeve outside of air stream.
      c. Temperature Rating: 165°F (74°C) or 212°F (100°C) for high temperature duct applications.
      d. Mounting: Vertical or horizontal
      e. Frame: 5” wide by 16-gauge roll formed, galvanized steel hat-channel, minimum.
      f. Sleeve: Minimum 20-gauge thickness and minimum 16” long.
      g. Bearings: Stainless steel, permanently lubricated sleeve type.
      h. Each damper shall be equipped with a controlled 15 second electric heat-actuated release device. This device is to be equipped with a push-button reset. No manual fusible links are permitted. Installation shall be in accordance with damper manufacturer's instructions. Coordinate power and smoke detector connections with electrical installer. Integral smoke detection and actuating devices may be used if listed and approved for such service. Comply with building code requirements. All combination fire and smoke dampers shall automatically reset from closed to open position upon the reapplication of power to actuators, if temperature switch is not tripped.
      i. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error.
      j. Voltage: Coordinate with Division 26 work and electrical installer for power to damper actuator. Provide 24 VAC, 120 VAC or 230 VAC power option to match power supply provided by Division 26. Prior to purchase and

installation coordinate with Division 26 to align power requirements at no additional cost to Owner.

k. Electric Actuators: All gear and housing shall be steel. The actuator shall be direct coupled and employ a steel toothed cold-weld clamp for connecting to damper shafts. Aluminum clamps or set-screw attachments are not acceptable. Actuator shall be UL listed and manufactured under ISO 9001 quality control.
   1) Actuator shall carry a manufacturer's 5-year warranty.
   2) Damper position shall fail closed on loss of power.
   3) Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible. Actuator shall be incapable of burning out if stalled before full rotation is reached.
   4) Actuator shall have UL555S Listing by the damper manufacturer and be rated for 20,000 cycles minimum. Actuator shall draw no more than 0.23 amps at 120-volt running, or 0.11 amps holding at 120-volt (27 VA and 10 VA respectively for 24-volt power) for 70 in.lbs. torque.
   5) Stall and instantaneous type actuators are not acceptable.
   6) Do not install in areas where moisture can penetrate damper or actuator, nor where actuator temperature exceeds 122°F (50°C).
   7) Manufacturer: Belimo #FS Series or equal by Siemens, Johnson Controls, or Honeywell.

3. Required Options:
   a. Provide open or closed indicator assembly consisting of a single pole, double throw switch used to indicate damper blade position. Include switch mounting bracket, crank arm, blade bracket and linkage from blade to the switch. Or, provide optional actuator end switches to indicate damper open and damper closed positions. Coordinate with fire alarm system and FireFighter's Smoke Control Panel for remote indication and damper override control.
   b. Provide a damper mounted testing module to permit test cycling of the damper actuator assembly as required for start-up testing and maintenance.
   c. Provide integral duct smoke detector and coordinate with Division 26 for area smoke detection and comply with NFPA-90A and NFPA-72. All wiring to be provided by Division 26 installers. In buildings not equipped with an approved fire alarm system the smoke detection activation shall cause a visual signal and audible signal in a normally occupied area and be identified as air duct detector trouble.For exposed wall applications provide matching wall grille to maintain appearance and fire rating.
   e. Temperature limited override: Provide a two-temperature electronic high temperature limit. A primary sensor at 165°F (or higher temperature as dictated by AHJ or Building Code) can be bypassed by an external electrical signal allowing the damper to reopen and remain open until the temperature reaches the setting of the secondary sensor at 350°F at which

point the damper is closed and remains closed. Both sensors are to be equipped with manual resets.

4. Low Velocity Applications (1500 fpm or below):
   a. Maximum Rate Velocity: 1500 fpm.
   b. Style: 3V grooved blades or airfoil-shaped, single piece, double skin with mechanically fastened silicone edge seals.
   c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10” w.g. at full air flow.
   d. Pressure rating: 4” w.g.
   e. Manufacturers: Ruskin #FSD37 or #FSD60 or #FSD60-3, Ruskin #FSDR25 or #FSDR60 round style, Greenheck #FSD-211 or #FSD-231 or #FSD-311 or #FSD-311M, or equal by Pottorff, Nailor, Cesco or Air Balance.
5. High Velocity Applications (Greater than 1500 fpm):
   a. Maximum Rate Velocity: 4000 fpm.
   b. Style: True airfoil-shaped, extruded aluminum blades with silicone edge seals.
   c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.20” w.g. at full air flow.
   d. Pressure rating: 4” w.g.
   e. Manufacturers: Ruskin #FSD60 or #FSD60-3, Greenheck #FSD-211 or #FSD-231 or #FSD-311 or #FSD-331, or equal by Pottorff, Nailor, Cesco or Air Balance.
6. Low and Medium Velocity Round Applications (3000 fpm or below):
   a. Maximum Rate Velocity: 3000 fpm.
   b. Style: Two piece 14-gauge thickness galvanized steel with mechanically fastened silicone edge seals
   c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.15” w.g. at full air flow.
   d. Pressure rating: 4” w.g.
   e. Manufacturers: Ruskin #FSDR25 or #FSDR60, Greenheck #FSDR-511, or equal by Pottorff, Nailor, Cesco or Air Balance.
7. Corridor Ceiling Application:
   a. Maximum Rate Velocity: 1500 fpm.
   b. Style: 3V grooved blades or airfoil-shaped, single piece, double skin with mechanically fastened silicone edge seals.
   c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10” sp w.g. at full air flow.
   d. Pressure rating: 4” w.g.
   e. Manufacturers: Ruskin #FSD60-C, Greenheck #CFSD-211, or equal by Pottorff, Nailor, Cesco or Air Balance.

E. Smoke Dampers (SD):
   1. Required Locations:
      a. Install at rated smoke barriers and partitions as defined on Architectural drawings and Chapter 7 of the Building Code.
      b. Per NFPA-90A install smoke dampers in systems with a capacity greater than 15,000 cfm to isolate the air handling equipment from the remainder of the system on the building supply and return side. Air handling units located on the floor they serve and only serving that floor are exempt. Air handling units located on the roof and serving only the floor immediately below the roof shall be exempt.
   2. General Requirements:
      a. Dampers shall be Low Leakage Class 1 in accordance with UL 555S.
      b. Dampers shall be provided as a manufactured UL listed device with electric actuator. Actuator shall be attached to sleeve outside of air stream.
      c. Temperature Rating: 165°F (74°C) or 212°F (100°C) for high temperature duct applications.
      d. Mounting: Vertical or horizontal
      e. Frame: 5” wide by 16-gauge roll formed, galvanized steel hat-channel, minimum.
      f. Sleeve: Minimum 20-gauge thickness and minimum 12” long.
      g. Bearings: Stainless steel, permanently lubricated sleeve type.
      h. Smoke damper shall be equipped for vertical wall penetrations with manufacturer supplied sleeve and fail closed on loss of power. Each damper shall be equipped with a controlled 15 second electric heat-actuated release device. This device is to be equipped with a push-button reset. No manual fusible links are permitted. Installation shall be in accordance with damper manufacturer's instructions. Coordinate power and smoke detector connections with electrical installer. Integral smoke detection and actuating devices may be used if listed and approved for such service. Comply with building code requirements. All combination smoke and fire dampers shall automatically reset from closed to open position upon the reapplication of power to actuators, if temperature switch is not tripped.
      i. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error.
      j. Voltage: Coordinate with Division 26 work and electrical installer for power to damper actuator. Provide 24 VAC, 120 VAC or 230 VAC power option to match power supply provided by Division 26. Prior to purchase and installation coordinate with Division 26 to align power requirements at no additional cost to Owner.
      k. Electric Actuators: All gear and housing shall be steel. The actuator shall be direct coupled and employ a steel toothed cold-weld clamp for connecting to damper shafts. Aluminum clamps or set-screw attachments are not acceptable. Actuator shall be UL listed and manufactured under ISO 9001 quality control.

1) Actuator shall carry a manufacturer's 5-year warranty.
2) Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible. Actuator shall be incapable of burning out if stalled before full rotation is reached.
3) Actuator shall have UL555S Listing by the damper manufacturer and be rated for 20,000 cycles minimum. Actuator shall draw no more than 0.23 amps at 120-volt running, or 0.11 amps holding at 120-volt (27 VA and 10 VA respectively for 24-volt power) for 70 in-lb torque.
4) Stall and instantaneous type actuators are not acceptable.
5) Do not install in areas where moisture can penetrate damper or actuator nor where actuator temperature exceeds 122□F (50°C).
6) Manufacturer: Belimo #FS Series or equal by Siemens, Johnson Controls, or Honeywell.

3. Required Options:
   a. Provide open or closed indicator option assembly consisting of a single pole and a double throw switch used to indicate damper blade position. Output from switch to position indicator light (LED, provided by Division 26) is by automatic temperature control contractor. Include switch mounting bracket, crank arm, blade bracket and linkage from blade to the switch.
   b. Provide a test module to permit test cycling of the damper/actuator in the field
   c. Provide integral duct smoke detector or coordinate with Division 26 for area smoke detection. Division 26 to provide all wiring.For exposed wall applications provide matching wall grille to maintain appearance and fire rating.
4. Low Velocity Applications (1500 fpm or below):
   a. Maximum Rate Velocity: 1500 fpm.
   b. Style: 3V grooved blades or airfoil-shaped, single piece, double skin with mechanically fastened silicone edge seals.
   c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.10" sp w.g. at full air flow.
   d. Pressure rating: 4" w.g.
   e. Manufacturer: Ruskin #SD-37, Ruskin #SD-60, Greenheck #SMD-201, Pottorff #SD-141, Pottorff #SD-151, or equal by Nailor, Cesco or Air Balance.
5. High Velocity Applications (Greater than 1500 fpm):
   a. Maximum Rate Velocity: 4000 fpm.
   b. Style: True airfoil-shaped, extruded aluminum blades with silicone edge seals.
   c. Allowable Pressure Drop: size damper as shown on drawings and as required to not exceed maximum allowable pressure drop of 0.20" sp wg at full air flow.
   d. Pressure rating: 4" wg.

e. Manufacturer: Ruskin #SD-50, Greenheck #SMD-401, or equal by Pottorff, Nailor, Cesco or Air Balance.

2.19 DUCT SILENCERS

A. Sound traps shall be IAC Acoustics, Vibro-Acoustics, Aerosonics, United McGill, Pottorff, Ruskin, Nailor or equal. Sound traps shall be sized for a maximum air pressure drop and maximum air velocity as noted on schedule.

B. Materials
1. Outer casings of rectangular silencers shall be made of 22-gauge type #G-90 lock-former-quality galvanized steel.
2. Interior partitions for rectangular silencers shall be not less than 26-gauge type #G-90 galvanized lock-former-quality perforated steel.
3. Filler material shall be as indicated on the Schedules and as appropriate for the application:
   a. Standard fill: Filler material shall be inorganic glass fiber of a proper density to obtain the specified acoustic performance and be packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin- and moisture-proof.
   b. Encapsulated fill for hospital or clean room applications: Filler material shall be inorganic glass fiber of a proper density to obtain the specified acoustic performance and be packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin- and moisture-proof. Filler material shall be totally encapsulated and sealed with polymeric film of an appropriate thickness. The encapsulated fill material shall be separated from the interior perforated baffles by means of a noncombustible, erosion resistant, factory-installed, acoustic stand-off. It shall not be acceptable to omit the acoustic stand-off and try to compensate for its absence by means of corrugated baffles.
   c. Packless sound traps: No sound absorptive material of any kind is to be used in the silencers. The silencers shall attenuate air/gas transmitted noise solely by virtue of controlled impedance membranes and broadly tuned resonators.
   d. “Green” fill alternate: Acoustic fill material shall be 100% environmentally friendly, and constructed of recycled natural fibers. Each fiber shall be treated with an EPA registered fungal inhibitor in order to prevent mold, mildew, fungi, and pest protection. The fill material must not contain any harmful chemicals, irritants, and/or volatile organic compounds (VOCs) in order to prevent off-gassing.
4. Combustion ratings for the silencer acoustic fill shall be not greater than the following when tested to ASTM E 84, NFPA Standard 255, or UL No. 723:
   a. Flame Spread Classification: 25
   b. Smoke Development Rating: 50

C. Construction
1. Units shall be constructed in accordance with the ASHRAE Guide recommendations for high pressure duct work. Seams shall be lock formed and mastic filled. Rectangular casing seams shall be in the corners of the silencer shell to provide maximum unit strength and rigidity. Interior partitions shall be fabricated from single-piece, margin-perforated sheets and shall have die-formed entrance and exit shapes so as to provide the maximum aerodynamic efficiency and minimum self-noise characteristics in the sound attenuator. Blunt noses or squared off partitions will not be accepted.
2. Attachment of the interior partitions to the casing shall be by means of an interlocking track assembly. Tracks shall be solid galvanized steel and shall be welded to the outer casing. Attachment of the interior partitions to the tracks shall be such that a minimum of 4 thicknesses of metal exist at this location. The track assembly shall stiffen the exterior casing, provide a reinforced attachment detail for the interior partitions, and shall maintain a uniform airspace width along the length of the silencer for consistent aerodynamic and acoustic performance. Interior partitions shall be additionally secured to the outer casing with welded nose clips at both ends of the sound attenuator.
3. Sound attenuating units shall not fail structurally when subjected to a differential air pressure of 8-inches water gauge from inside to outside the casing. Airtight construction shall be provided by use of a duct sealing compound on the jobsite material and labor furnished by the contractor.

D. Acoustic Performance
1. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM Specification E477-99. The test facility shall be NVLAP accredited for the ASTM E477-99 test standard. Data from a non-accredited laboratory will not be acceptable. The test set-up and procedure shall be such that all effects due to end reflection, directivity, flanking transmission, standing waves, and test chamber sound absorption are eliminated. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self-Noise (SN) Power Levels both for FORWARD FLOW (air and noise in same direction) and REVERSE FLOW (air and noise in opposite directions) with airflow of at least 2000 fpm entering face velocity. Data for rectangular and tubular type silencers shall be presented for tests conducted using silencers no smaller than the following cross-sections:
   a. Rectangular, inch: 24x24, 24x30, or 24x36, and
   b. Tubular, inch: 12, 24, 36, and 48

E. Aerodynamic Performance
1. Static pressure loss of silencers shall not exceed those listed in the silencer schedule as the airflow indicates. Airflow measurements shall be made in accordance with ASTM specification E477-99 and applicable portions of ASME, AMCA, and ADC airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented.

2.20 AIR BLENDERS

A. Prove air blenders of size as shown on Drawings, constructed of heavy gauge aluminum, all welded. Units shall be factory constructed and tested, and installed in accordance with manufacturer's recommendations. RM Products Co, Blender Products. or equal.

PART 3 - EXECUTION

3.01 DUCTWORK GENERAL REQUIREMENTS

A. Fabricate ducts with galvanized sheet steel, except as otherwise indicated and as follows:
   1. All duct system appurtenances are to be the same material as ductwork including volume dampers and access panels.
   2. Where duct joints are not connected using flanges or manufactured assemblies, provide sheet-metal screws equally spaces around the joint or equivalent fastening method as required by mechanical code and SMACNA HVAC Duct Construction Standards-Metal and Flexible. Where sheet-metal screws are utilized provide a minimum of three screws on round ductwork and minimum four screws on rectangular ductwork. Maximum spacing between screws shall not be greater than 12” on center.
   3. Humidifier ductwork: Ductwork for humidifiers shall be constructed of 20-gauge stainless steel ductwork with longitudinal seam at top of horizontal runs and all joints sealed watertight. Duct length shall be as required by humidifier manufacturer, or as shown on drawings whichever is greater, to allow for full absorption of water vapor. This portion of duct shall include an integral drain pan and drain line connection.
   4. Shower Rooms: Exhaust ductwork serving shower rooms or other wet areas shall be constructed of stainless steel or aluminum. Where shower room exhaust ducts connect to a general exhaust riser, the non-ferrous ductwork with sealed joints need only extend to point of connection to the general exhaust riser.
   5. Environmental exhaust ductwork serving domestic clothes dryers shall be constructed of metal and shall have smooth interior surface. Provide backdraft damper at discharge to atmosphere.
   6. Non-toxic and non-hazardous wet vapor exhaust, such as dishwasher, sterilizers, cart washers, and shower exhaust systems:
      a. Material: Type 304 or 316L stainless steel, minimum 24-gauge spiral or sheet metal ductwork with G90 zinc coating. Type 304 or 316L stainless steel fittings.
      b. Joints: welded, or swaged lap-joint with silicon caulk and stainless steel sheet metal screws.
      c. All accessories shall be stainless steel including dampers, damper hardware and turning vanes.

3.02 DUCTWORK CONSTRUCTION AND SEALING CRITERIA

A. Leakage classification of ductwork shall conform to the minimum requirements of Table 3.1 and Table 3.2 (see below) based on procedures of "SMACNA HVAC Duct Construction Standards-Metal and Flexible" and "SMACNA HVAC Air Duct Leakage Test Manual" as follows:

TABLE 3.1 DUCT LEAKAGE CLASSIFICATION			
DUCT WORKING PRESSURE CLASS	AIR PRESSURE LESS THAN +/- 0.5"WC	AIR PRESSURE +/-0.5" TO +/-2.99"	AIR PRESSURE +/-3" TO +/-10" WC
SMACNA Seal Class	C	B	A
Sealing Applicable	Transverse joints	Transverse joints and longitudinal seams	Transverse joints longitu-dinal seams and all duct wall penetrations
LEAKAGE CLASS			
Rectangular sheet metal SMACNA Leakage Class	6	6	4
Round sheet metal SMACNA Leakage Class	6	4	2
Note: Duct sealant ranges and classification are generally more restrictive than SMACNA guide-lines.			

B. Ductwork shall be constructed to SMACNA pressure class based on 150% of the maximum working pressure at connection to air handling unit, or better as specified herein. Unless called out otherwise on drawings the pressure classification of ductwork shall be as follows:

TABLE 3.2 DUCT CONSTRUCTION CLASSIFICATION				
DUCT SYSTEM	**LOCATION**	**WORKING PRESSURE (ESP FROM SCHEDULE)**	**BUILD TO SMACNA PRESSURE CLASS**	**BUILD TO SMACNA SEAL CLASS**
Outdoor air intake	From outdoor air in-take to AHU	-1" wc	-2" wc	B
Low pressure supply air	Downstream of air terminal units to grilles, registers or diffusers.	+0.5"	+1" wc	B

TABLE 3.2
DUCT CONSTRUCTION CLASSIFICATION

DUCT SYSTEM	LOCATION	WORKING PRESSURE (ESP FROM SCHEDULE)	BUILD TO SMACNA PRESSURE CLASS	BUILD TO SMACNA SEAL CLASS
Low pressure supply air	From AHU to grilles, registers or diffusers.	+0.5 wc	+1” wc	B
Low pressure return air	From return grilles to AHU	-0.5” wc	-1” wc	B
Transfer air	From grille to grille, or acoustic boots or “z” bends	-/+0.25” wc	-/+0.5” wc	C
Med pressure supply air	From AHU to air terminal units	+6” wc	+10” wc	A
Med pressure supply air	From AHU to air terminal units	+4” wc	+6” wc	A
Med pressure supply air	From AHU to air terminal units	+2” wc	+3” wc	A
Med pressure return air	From air terminal units to AHU	-3” wc	-4” wc	A
Med pressure return air	From air terminal units to AHU	-2” wc	-3” wc	B
Med pressure return air	From air terminal units to AHU	-1” wc	-2” wc	B
Relief air	From AHU to discharge at outdoors	+1” wc	+2” wc	B
General exhaust	From grille to exhaust fan	-1” wc	-2” wc	B
General exhaust	From exhaust fan to discharge at outdoors	+1” wc	+2” wc	B
Toilet/shower room exhaust	From grille to exhaust fan	-1” wc	-2” wc	B
Toilet/shower room exhaust	From exhaust fan to discharge at outdoors	+1” wc	+2” wc	B

3.03 DUCTWORK LEAKAGE TESTING

A. Refer to Section 23 0593 Testing, Adjusting and Balancing for air leakage testing requirements and procedures.

3.04 DUCTWORK SPECIALTIES INSTALLATION

A. Ductwork is generally diagrammatically indicated and shall be generally installed as indicated. Do not scale Drawings for exact location of ducts. Install ducts to best suit field conditions and cooperate with other trades. Do not penetrate Structural members without consent of Architect or Structural Engineer. Check with Structural drawings prior to locating any penetrations. Duct sizes are indicated as net inside dimensions on the Drawings. The indicated dimensions shall be altered at the job site for the purpose of avoiding interferences and clearance difficulties to other dimensions producing the same air handling characteristics, provided such altered dimensions are approved by the Architect. Ducts shall be constructed in accordance with the latest edition of codes and standards identified in Part 1 and as shown on the Drawings.

1. Grilles, Registers and Diffusers: Install flush, squared, tightly sealed, and entirely covering sheet metal ductwork and gaskets. Thread sheet metal mounting screws tightly into sheet metal. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper only where individual duct mounted balancing dampers are specifically noted as not provided. Duct connections shall fit securely to necks or collars behind face area. Provide all necessary transition pieces and duct collars to make connections from ductwork to neck sizes. Where ducts connect directly to necks or collars provide a minimum straight duct section of two times the duct diameter to the last elbow. Where minimum straight duct sections are not physically possible provide sheet metal plenum sized for approximately 500 fpm air velocity with duct tapped directly to side of plenum. Where building walls, floors and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted and sealed to building structure.
2. Install turning vanes in all mitered elbows in all ducts, so that tips are parallel with the sides of the ducts. Tips of acoustical turning vanes on outside radius shall be flush with acoustical lining.
3. Provide flexible connections to completely isolate fans from direct contact with all sheet metal work.
4. Provide access doors, as required, for access to valves, controllers, dampers and humidifier dispersion tubes. Access doors required in Product Conveying Vapor/Moisture Ductwork (see applicable paragraph above) shall not be installed in the bottom of the duct or in a manner to allow leaks.
5. Volume Dampers: Provide manual volume dampers in all supply, return and exhaust branch and run-out ductwork to grilles, diffusers, registers, and other inlet and outlet openings to facilitate balancing of air distribution systems. These are to be provided as part of contract whether shown on plans or not. Where ceilings are not accessible, provide access door or remote damper regulator. Volume dampers must be installed immediately downstream of each duct takeoff.
6. Multi-Blade Control Dampers: Provide control dampers as shown on drawings. Coordinate with BAS system provider for control actuators.

7. Clean and pretreat surfaces before application of sealant. Conform to the manufacturer's cleaning procedures. Install sealants in conformance with manufacturer's instructions.
8. Except where noted, vertical ducts or horizontal ductwork penetrating fire rated ceilings, roofs, walls and floors shall be fire separated with UL listed and labeled fire dampers installed per UL tested assembly including sleeves and retaining angles. Provide additional fire dampers indicated on the Drawings and as otherwise required by the IBC and building inspector. Provide approved firestopping between damper frames and firewalls. Install fire dampers in accordance with NFPA Standards, requirements of the State Fire Marshal, and applicable codes. Ensure that fire dampers are installed in the open position.
9. For penetration of fire rated partitions which meet the IBC Chapter Seven requirements of non-Group H occupancy penetration of tenant separation and corridor walls in buildings with fire sprinklers provide metal sleeves as follows: A minimum 12 inch-long (0.30 m) by 0.060-inch-thick (1.52 mm) steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 1-1/2" by 1-1/2” by 0.060-inch steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 screws. The annular space between the steel sleeve and wall opening shall be filled with rock wool batting on all sides.

B. Hangers and Supports: Securely fasten all ductwork to the building construction by means of hangers, supports, guides, anchors, and sway braces to maintain duct alignment, to prevent sagging, and to prevent noise and excessive strain on ductwork due to movement under operating conditions.
   1. Maximum spacing between hangers shall not exceed ten (10) feet for rectangular sheet metal ductwork and twelve (12) feet for spiral round sheet metal ductwork. Provide hanger at each change in direction and at each branch takeoff. Refer to “SMACNA HVAC Duct Construction Standards Metal and Flexible” for additional requirements.
   2. Provide duct supports within two (2) feet of each: duct elbow; connection to flexible ductwork; connection to terminal units; connection to fan coil units; connection to exhaust fans, connection to air handling units, and fire and/or smoke dampers.
   3. Adequately mount and anchor all material and equipment as required. Include lateral bracing as required to prevent horizontal, seismic movement. Refer to IBC and Architectural and Structural Drawings for seismic requirements.
   4. Do not support ductwork from other ducts, pipes, fans or any other pieces of equipment.
   5. Powder driver fasteners shall not be used to support rectangular ducts larger than 40" maximum dimension. Powder driven fasteners shall not be allowed in existing facilities.
   6. Support round duct, larger than 36", shall have two hangers at each support point.
   7. Hangers and supports shall conform to SMACNA section "Hangers and Supports". Nail inserts, hangers and supports to formwork before slabs are

poured. Cut off or remove nails, strap-ends and other projections, flush with concrete after forms are removed.

8. Support vertical ducts, passing through floors with two continuous angles screwed to the duct and bearing to the floor and conforming to SMACNA section "Riser Support-From Floor". Blocking or shimming ducts will not be permitted.

C. Other:

1. Fans: Align fans, motors, and drives. Install fans to render bearings accessible for lubrication without dismantling fans or ducts. Provide extended bearing oilers as required. Mount all fans on vibration isolators as specified.
2. Insulation: Properly and neatly apply insulation on all material and equipment and apparatus, as specified, including all fittings. Apply insulation over clean, dry surfaces, with adjoining sections firmly butted together and canvas smoothly pasted over. When vapor barriers are specified, install continuous overall external surfaces of the entire system.
3. Duct Sizing: Where duct sizes are not specifically shown on the plans or must be modified due to physical limitations, supply ducts may be sized at a maximum velocity of 1,500 fpm or 0.08" sp friction per 100 feet, whichever provides the larger duct, and return/exhaust/intake ducts may be sized at a maximum velocity of 1,000 fpm or 0.06" sp friction per 100 feet, whichever provides the larger duct. Refer to Basis of Design for further duct sizing criteria.
4. Humidifiers: Humidifier installation shall be approved by manufacturer and coordinated with all other systems. Condensate piping shall include p-traps as recommended by the humidifier manufacturer. Insulate exposed piping as required by the code.
5. Exterior Ductwork: Ductwork located and installed outside the building envelope, on roof, grade or other location exposed to weather, shall be constructed and sealed airtight and watertight. The top of exterior ducts shall be cross-broken and sloped 1% towards edge of duct to eliminate any locations where rainwater can collect. Or, provide additional duct supports and mounting adjustments as necessary to prevent water retention on top of ductwork.
6. Double Wall Ductwork: Insulated ductwork located and installed outside the building envelope may be constructed of two layers of galvanized sheetmetal encapsulating the insulation layer. The inner duct shall be constructed as the main carrier duct with gauge and fabrication as required per the SMACNA Duct Construction Standards and minimum 24-guage. The insulation layer shall be provided as required by the local energy code or Section 23 0713 Duct Insulation, whichever is greater. The outer sheetmetal layer shall be a non-pressurized layer, minimum 24-gauge, to encapsulate the insulation layer to prevent weather degradation and optimize the insulation effectiveness for the life of the building. The top layer shall be crossbroken and sloped 1% towards edge of duct to eliminate any locations where rainwater can collect. Or, provide additional duct supports and mounting adjustments as necessary to prevent water retention on top of ductwork.

7. Access Floor Diffusers: The mounting ring for floor mounted diffusers are to be affixed to the floor tiles using a clamp insert or other method approved for use with the floor diffuser.

3.05 FLEXIBLE DUCTWORK INSTALLATION

A. Flexible insulated round ductwork connectors may be utilized where shown on the Drawings and for transitions between air handling equipment and rigid ductwork. A five (5) foot (maximum) length of flexible air duct shall be allowed to be used as an elbow at a terminal devices or air outlet/inlet, unless shown otherwise on the Drawings. No intermediate joints are allowed. Seal each end using two wraps of tape listed in accordance with UL 181B and marked 181B-FX, followed by a mechanical stainless steel screw operated drawband. Plastic drawbands are not allowed. Support duct to maintain smooth shape without sagging. All connections shall utilize welded conical tees, aluminum conical fitting, Flexmaster #CBD, or 45° boot take-offs by Flexmaster #STO. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted. Damper regulators shall include end bearings as manufactured by DuraDyne, Ventlok or equal.

B. Flexible duct runouts to diffusers and grilles is limited to the following sizes:
1. 6” diameter: Up to 100 cfm
2. 8” diameter: Up to 200 cfm.
3. 10” diameter: Up to 360 cfm.
4. 12” diameter: Up to 600 cfm.
5. 14” diameter: Up to 900 cfm.

3.06 EXPANSION JOINTS

A. At a non-rated penetration through an expansion joint wall:
1. Provide insulated flexible ductwork through expansion joint. Flexible connector shall be no longer than five feet between segments of rigidly attached ductwork.

B. At a fire/smoke rated penetration through an expansion joint wall:
1. Provide required fire/smoke damper with sleeve through rated assembly as required by Building Code and manufacturer’s instructions. Provide breakaway duct connections as required by manufacturer’s listing. Ductwork bracing on either side of wall must not be rigid within ten feet of wall to allow for building movement. Seismic restraints must not be closer than ten feet of expansion joints on either side of wall. Following a building seismic/movement event the ductwork will need to be inspected and possibly reattached to the fire/smoke damper.

3.07 DUCT SILENCER REQUIREMENTS

A. Install the duct silencer per manufacturer's basic installation instruction.

B. Do not locate duct silencers within one duct diameter from fan discharge/intake openings, elbows, or takeoffs.

C. Where multiple duct silencer units are grouped together in parallel within the duct system they shall be sealed airtight at all joints.

3.08 FABRIC AIR DISPERSION SYSTEM

A. Clean each air handling unit and rigid ductwork prior to installing the fabric air dispersion duct system.

B. Temporary Closure: At ends of ducts which are not connected to equipment of distribution devices at time of ductwork installation, cover with fire retardant film or other covering which will keep the ductwork system clean until installation is completed.

C. If fabric air dispersion system becomes soiled during installation, these sections should be removed and cleaned following the manufacturer's standard terms of laundry.

3.09 STAINLESS STEEL DUCTWORK

A. For installations serving moisture, vapor, or fume exhaust.
   1. For connections to hoods or equipment provide minimum 12" length flanged and bolted stainless steel spool piece connection.
   2. All fittings shall be long radius. Round elbows shall be minimum 5-gore.
   3. Slope horizontal ductwork back toward source connected equipment minimum 1% slope so that moisture and liquids may drain back toward equipment.
   4. Low point "traps" in the ductwork shall be fitted with a low point drain valve, 1/2" welded connection, stainless steel piping and valve.
   5. All welding to be completed by certified welders experienced in 316 stainless steel.

3.10 DUCTWORK SEALANT METHODS

A. General
   1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
   2. All installation shall be in accordance with manufacturer's published recommendations.
   3. Cleanliness:
      a. Before installing sealant, Surface must be dry and be free of dirt, oil, grease, and loose or foreign matter that could impair adhesion wipe ductwork to a visibly clean condition.
      b. During construction, provide temporary closures of metal or taped polyethylene on open ductwork and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends of ductwork

prior to installation to keep ductwork interior clean. Remove closures only for installation of the next duct section.

c. During duration of construction, maintain the integrity of all temporary closures until air systems are activated.

d. Follow the Advanced Level requirements as found in the SMACNA Duct Cleanliness for New Construction Guidelines.

B. Installation of Mastic/Sealant Duct System

1. One Part Sealant System:

a. Apply one-part sealant system at a 20 to 30 wet mil thickness with a brush, putty knife; caulk gun or spray to duct joints, fasteners and seams. Tool, if necessary, caulk bead with putty knife or brush. Let dry per manufacturer data sheet of a minimum of 48 hours.

2. Or, One Part Spray Applied Sealant System:

a. Use a manufacturer approved airless sprayer capable of application pressure up 2,000 psi spraying through a minimum 0.111 tip. Apply in a smooth application perpendicular to the substrate at a rate of 20 to 30 wet mils to joints, seams and duct wall penetrations per manufacturer's technical data sheet. Let dry per manufacturer data sheet of a minimum of 48 hours.

C. Installation of Mastic/Sealant Duct System with 10-Year Warranty

1. Installation of Rolled Sealant Tape over Mastic/Sealant:

a. Cut desired length for each side of the ductwork; peel off release liner and center over joint, seam or penetration. The rolled sealant should completely cover the sealant. Use hand pressure to place the rolled sealant followed by a squeegee application. Lap tape end 2 inches (50 mm minimum). Squeegee rolled sealant to insure bond and complete adhesion to the duct. Instant adhesion requires precise positioning. Not re-positional. Four-Bolt flange requires applying corner pieces prior to applying the edge strips.

D. Field Quality Control

1. Allow duct sealant system to cure minimum 48 hours before pressure testing for the fluid applied Sealants. Rolled sealants can be tested immediately with duct leakage tester.
2. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork insulation.
3. Notify Owner's Representative a minimum of seven (7) calendar days in advance of leakage testing.
4. Leaks identified during ductwork air leakage testing shall be repaired by:
5. Complete removal of the sealing materials.
6. Thorough cleaning of the joint surfaces.
7. Installation of multiple layers of sealing materials.
8. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings shall result in re-inspection, repair and retest until discrepancies are eliminated.

3.11 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.12 FIBERGLASS DUCTWORK INSTALLATION

A. Fiberglass ductboard may be utilized as an option to sheet metal ductwork in the following applications and where indicated on the drawings:
   1. Return air transfer ducts between two adjacent rooms with maximum design static pressure in the following range: -0.5" w.g. to +0.5" w.g.

3.13 FIRE AND COMBINATION FIRE/SMOKE DAMPER INSTALLATION

A. Install per manufacturer’s and UL installation requirements.

B. For buildings with no fire alarm system all fire/smoke dampers shall be interconnected with the HVAC unit’s controls and duct smoke detectors. The detection of smoke at any fire/smoke damper shall stop for HVAC unit fans and close all fire/smoke dampers. A single test/reset station shall be capable or resetting all devices back to normal operation.

C. Smoke and fire/smoke dampers shall close upon activation of a listed smoke detector or detectors installed in accordance with Chapter 7 of the Building Code. Other than in mechanical smoke control systems, smoke and fire/smoke dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate. Coordinate with electrical installer for all work associated with smoke and fire/smoke damper wiring and smoke detector initiation.

3.14 CONTROL DAMPER INSTALLATION

A. Note that installation of control dampers is a part of the mechanical contractor’s work regardless of whether they are specified in this section or as part of products to be selected by the Control Contractor.

B. When electric actuators are provided, dampers shall be installed to allow direct over the shaft mounting of actuators. No connecting rods and stand off brackets shall be necessary.

C. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallellogramming), bowing, or other installation error.

D. Blades shall close completely. Leakage shall not exceed manufacturer's specifications at rated static.

E. Structural support shall be provided as necessary for all multi-section dampers.

F. Where blankoffs or structural supports obstruct duct or air passages, the decrease in free area shall not exceed 15% of the damper face area unless otherwise specified here or on plans.

G. No individual damper section may exceed 20 sq. ft.

H. Dampers shall be parallel blades style for outside air economizer to facilitate improved mixing of outside air and return air. Airflows shall be directed towards each other.

I. Where ducts penetrate an exterior surface install a Class I motorized damper at each outdoor air supply opening, exhaust opening, relief outlet, shaft vent and stairway vent, as required to comply with minimum requirements of the local Energy Code.
   1. Dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the system served requires outdoor air or exhaust air or operates continuously or the dampers are opened to provide intentional economizer cooling.
   2. Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

3.15 SEISMIC REQUIREMENTS

A. See Section 23 0549 for specific requirements.

B. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of four times gravity also acting at the center of gravity.

C. The seismic calculations shall be the responsibility of the structural engineer.

D. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with the California Building Code and ASCE/SEI 7.
   1. Space lateral supports a maximum of 40 feet (12 m) and longitudinal supports a maximum of 80 feet (24 m) on center.
   2. Brace each change of direction longer than 12 feet (3.7 m).

E. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install cable restraints on ducts that are suspended with vibration isolators.

H. Install seismic-restraint devices using methods approved by the AHJ.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

J. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.16 EQUIPMENT

A. Install equipment as shown on plans and in accordance with manufacturer's installation recommendations.

3.17 SUPPLY DIFFUSER AND REGISTER LOCATIONS

A. Coordinate location of supply outlets with ceiling mounted smoke detectors. Locate outlets or outlet distribution so as to prevent airflow from inhibiting the operation of smoke detectors. Locate ceiling outlets a minimum of 3'-0" from smoke detectors.

3.18 PAINTING

A. Where the interior surfaces of ductwork are visible through the blades of supply outlets, return inlets, and exhaust inlets - paint the interior visible surfaces with one coat of flat black paint.

B. Ductwork exposed on the roof or exterior to the building shall be painted. Coordinate with Division 9 for requirements.

3.19 FIELD QUALITY CONTROL

A. Do not insulate or conceal ductwork before inspection by Owner's Representative, Architect or Engineer. If ductwork is insulated and concealed prior this inspection the Contractor shall remove insulation and ceiling to permit inspection at no additional cost to the Owner. The Contractor shall replace the insulation and ceiling after final inspection at no additional cost to the Owner.

B. Ductwork Deflection Criteria:
   1. Maximum inward and/or outward deflection at sheet metal panels shall be 3/4" under maximum static pressure operating conditions. Additional intermediate stiffening angles shall be installed where deflections exceed 3/4".
   2. Maximum inward and/or outward deflection at sheet metal elbows and joints shall be 1/4" under maximum static pressure operating conditions. Additional stiffening angles shall be installed where deflections exceed 1/4".

C. Acceptance of duct systems shall be contingent upon conformance with the requirements specified in Section 23 0593 "Testing, Adjusting and Balancing".

3.20 ADJUSTING AND CLEANING

A. Clean the inside of plenums, casings, enclosures, fans, and accessible ductwork before starting fans. Blowout coils and condensate piping with compressed air. Comb all coil fins that may be bent. Install a clean set of filters in each system prior to testing and balancing. Proceed with testing and balancing. All dampers shall be locked in place.

3.21 DUCT SEALING ALTERNATIVE

A. Occasionally a ducted system will experience leaks after the ductwork has been installed and sealed per one of the SMACNA duct sealant classifications. These leaks may not be identifiable until after ductwork has been installed and system air balancing and leakage testing has been engaged. At the contractor’s option an alternative solution to sealing such leaks may include the use of a water based sealing agent that is introduced to the interior of the duct system.
   1. Manufacturer: Aeroseal LLC or approved equal. Application must be performed by manufacturer approved provider.
   2. Sealant must be UL 723 approved for smoke and flame spread.

3. Sealant must be UL 181 approved for humidity, mold growth, temperature, erosion and puncture resistance.

B. Duct Sealing Procedure:
   1. Preparation:
      a. Inspect the entire duct shaft and horizontal plenums for major leakage sites (larger than 1/2” across).
      b. Mechanically clean duct shaft per NADCA (National Air Duct Cleaners Associations) standards if more than 1/8” of surface contaminants are visible on duct surfaces.
      c. Repair all major leakage sites using mastic and fiberglass mesh tape per SMACNA standards.
      d. Temporarily remove or protect all building controls and smoke detectors from aerosol particles as recommended by the Manufacturer.
      e. Temporarily disable fire alarms and notify appropriate authorities.
      f. Temporarily isolate air-moving equipment and block off air inlets and air outlets as recommended by the manufacturer.
      g. Protect occupied spaces from aerosol particles as recommended by the Manufacturer.
      h. Protect air-moving equipment, air inlets and outlets and other devices and appurtenances as recommended by the manufacturers.
   2. Duct Sealing:
      a. Seal existing ductwork from the inside using automated aerosolized sealant injection as recommended by manufacturer or by manually caulking internally with sealant.
      b. Sealant must cure within 2 hours with no odor or VOC off-gasing thereafter.
      c. Sealant shall remain elastic (not harden rigidly) after curing.
      d. Sealant shall be deposited substantially at areas of leakage only, and shall not coat interior duct walls, duct lining material, dampers, or turning vanes.
      e. Seal all test holes using patching plates sealed with mastic.
      f. Repair or replace insulation to match existing.
      g. Seal all injection openings with duct access doors or replace ductwork to match existing.
   3. Duct Reassembly and Cleanup:
      a. Reinstall building controls and smoke detectors.
      b. Enable fire alarms and notify appropriate authorities.
      c. Remove blocking, reinstall grills and registers, and enable air handling fans.
      d. Cleanup sealant residue that may have adhered to surfaces in occupied areas as recommended by the Manufacturer.
      e. All work shall be done in a substantial and workmanlike manner by factory-trained technicians.
   4. Testing:
      a. Provide pre-sealing and post-sealing leakage profile reports indicating percentage reduction of duct leakage for both supply and return ductwork.

b. Retest ductwork and document compliance with air leakage requirements as identified in section 23 0593 Testing, Adjusting and Balancing.

5. Warranty:
   a. The Contractor shall warrant that the aerosol sealant application will be free from defects for a period of 3 years from date of the sealing application. If defects should occur during this period, the Contractor shall repair or replace the defective duct seals, including the direct labor costs for performing the repair or replacement, at no additional cost to the Owner.

END OF SECTION

SECTION 23 34 16 - INLINE FANS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
   1. Small Cabinet Fans (Ceiling Mounted)
   2. Cabinet Fans (Inline)

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods

B. Section 23 0593: Testing, Adjusting and Balancing

C. Section 23 3113: Air Distribution

D. Division 26: Electrical

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99: Standards Handbook
      b. 210: Laboratory Methods of Testing Fans for Rating
      c. 300: Reverberant Room Method for Sound Testing of Fans
      d. 320: Laboratory Methods of Sound Testing of Fans Using Sound Intensity
      e. 301: Methods for Calculating Fan Sound Ratings from Laboratory Test Data

2. American National Standards Institute (ANSI):
   a. 9: Load Ratings and Fatigue Life for Ball Bearings
   b. 11: Load Ratings and Fatigue Life for Roller Bearings
3. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
4. National Fire Protection Association (NFPA):
   a. 70: National Electrical Code
   b. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems
5. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
6. Underwriters Laboratories, Inc. (UL):
   a. UL 507: Standard for Electric Fan
   b. UL 705: Standard for Power Ventilators
   c. UL 1004: Standard for Rotating Electrical Machines-General Requirements

1.05 SAFETY PROVISIONS

A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with protective guards or screens, with maximum 1/2” openings, meeting OSHA requirements.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of 1/4” per one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.09 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 GENERAL FAN REQUIREMENTS

A. Construction, Rating and Testing: Provide fans constructed and factory tested in accordance with the Air Moving and Conditioning Association (AMCA). All fan wheels shall be statically and dynamically balanced. Size and capacity as indicated on the Drawings.

B. Motors and Drives: Provide premium efficiency drip-proof motors with temperature rise not greater than 40°C above ambient temperature.
   1. Belt Drive Fans: Provide belt drive assembly capable of 150% of the motor rated horsepower on one less than the total number of belts, for belt drives with two or more belts. All drives shall have adjustable sheaves to allow adjustment of +/- 20%. Provide premium efficiency multi-speed motors as indicated on the drawings.
   2. Direct Drive Fans: Provide ECM or premium efficiency motors as indicated on the drawings.

C. Accessories: Provide, as indicated on the drawings and specified in other paragraphs of this Section.

2.02 SMALL CABINET FANS (CEILING MOUNTED)

A. Ceiling mounted exhaust fans:
   1. Manufacturer: Greenheck SP-A, Panasonic, Cook, Penn, Carnes, Twin City, Air King or equal.
   2. General: Provide centrifugal direct drive type ceiling exhaust fan. The fan wheel(s) shall be of the forward curved centrifugal type and dynamically balanced.
   3. Noise Data: Provide sone or octave band noise values at the required air delivery.

4. Fan Housing: The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be lined with 1/2-inch acoustical insulation, or better. The outlet duct collar shall include a backdraft damper on all sizes and shall be spring loaded on larger units above 200 cfm.
   a. Integral backdraft damper shall be totally chatter-proof with no metal-to-metal contact.
   b. Entire fan, motor and wheel assembly shall be easily removable without disturbing the housing.
   c. Outlet shall be adaptable for horizontal or vertical discharge.
5. Motor speeds shall not exceed 1100 RPM and all fan motors shall be suitably grounded and mounted on rubber-in-shear vibration isolators.
6. Grille: For 300 cfm and smaller fans the grille shall be constructed of high impact polystyrene and for larger sizes the grille shall be constructed of aluminum. Grilles shall be non-yellowing.
7. The access for wiring shall be external. The motor disconnect shall be internal and of the plug-in type. The motor shall be mounted on vibration isolators.
8. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be UL/cUL Listed.

2.03 CABINET FANS

A. Inline Cabinet Fans (Belt Drive and Direct Drive)

B. Duct mounted supply, exhaust or return fans shall be of the centrifugal, direct drive or belt driven in-line type.

C. Housing: The fan housing shall be of the rectangular design constructed of heavy gauge galvanized steel or aluminum and shall include rectangular duct mounting collars. A hinged or removable panel shall be provided in the fan cabinet of sufficient size to permit access for service to all of the fan’s internal components without dismantling the cabinet.

D. The fan wheel shall be of the galvanized steel or aluminum, backward-inclined, centrifugal type. Wheels shall be dynamically and statically balanced. The wheel shaft shall be grounded and polished steel mounted in permanently sealed pillow block bearings.

E. Drives shall be sized for a minimum of 150% of driven horsepower. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.

F. Motors shall be of the heavy-duty type with permanently sealed ball bearings.
   1. Belt drive: Pulleys shall be of the machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.
   2. Direct drive: Electronically commutated (EC) motor with potentiometer dial mounted on motor for speed adjustment and 0-10 VDC control wire inputs for connecting to the building automation system for remote control.

a. Up to 3/4 hp: 115 volts
b. 1 hp: 115/208-230 volts
c. 2 hp and over: 208-230 volts

G. All fans shall bear the AMCA Certified Ratings Seal for air performance.

H. NEMA-1 disconnect switch to be factory mounted and wired.

I. Manufacturers: Greenheck #SQ and BSQ Series, Cook, Penn, Carnes, Twin City or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate motor starters with Division 26 and controls contractor.

B. Install in accordance with manufacturer's instructions.

C. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.

D. Install unit on vibration isolators.

E. Install 3" flexible duct connection at inlet and outlet of each unit.

F. Control installers shall install all wiring associated with control signals into the fan starters.

G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

3.02 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four-hours travel time from the job site.

END OF SECTION

SECTION 23 73 14 - DEDICATED OUTSIDE AIR HANDLING UNITS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Air Handling Units
   2. Fans

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic HVAC Materials and Methods

B. Section 230593: Testing, Adjusting and Balancing

C. Section 230902: Variable Frequency Drives (VFD)

D. Section 230700: Mechanical Insulation

E. Section 233113: Air Distribution

F. Division 26: Electrical

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 - Standards Handbook

b. 210 - Laboratory Methods of Testing Fans [Unit shall bear AMCA Certified Rating Seal]
c. 300 - Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
e. 500 - Test Method for Louvers, Dampers, and Shutters

2. American National Standards Institute (ANSI):
   a. 9 - Load Ratings and Fatigue Life for Ball Bearings
   b. 11 - Load Ratings and Fatigue Life for Roller Bearings
   c. 900 - Test Performance of Air Filter Units
3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
   a. 340/360 – Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
   b. 410 - Forced-Circulation Air-Cooling and Air-Heating Coils
   c. 430 - Central-Station Air-Handling Units
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 - Safety Code for Mechanical Refrigeration
   b. 193 – Method of Test for Determining the Air Leakage of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 - National Electrical Code
   b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.
9. Units shall be listed and labeled by either UP or ETL for air handler construction.

1.05 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.

2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for packaged units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 1.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.09 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 DOAS HEATING/COOLING UNIT

A. GENERAL:
1. Outdoor rooftop mounted, electrically controlled heating and cooling unit. Unit shall discharge supply air downward or horizontally as shown on contract drawings.
2. Unit shall be rated in accordance with ARI Standards 210, 240 and 270. Designed in accordance with UL Standard 465.
3. Unit shall be designed to conform to ANSI/ASHRAE 15.
4. Unit shall be UL tested and certified in accordance with ANSI Z21.47 Standards and CSA or CGA certified as a total package.
5. Roof curb shall be designed to conform to NRCA Standards.
6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

B. Manufacturers: iAIRE, Carrier, Trane, Daikin, York, Lennox, Aaon, Engineered-Air, or equal.

C. Equipment:
1. General:
a. Factory assembled, single piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A) and special features required prior to field start-up.
2. Unit Cabinet:
a. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
b. Insulation: See Table below.
c. Cabinet panels shall be easily removable for servicing. See Table below.
d. Filters will be accessible through a hinged access door, and will require no panel or screw removal.
e. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
f. Unit shall have a factory installed internal condensate drain trap made of a non-corrosive material, providing a minimum 3/4" connection.
3. Fans:
a. Indoor blower (evaporator fan):
1) Fan shall be direct or belt driven as specified here (See matrix below). If belt driven the drive shall include an adjustable pitch motor pulley.
2) Bearings shall be sealed, permanently lubricated ball bearing type for longer life and lower maintenance.
b. Indoor blower shall be made from steel with a corrosion resistant finish and shall be dynamically balanced.

c. Outdoor (condenser) fan shall be of the direct driven propeller type and shall discharge air vertically upward.

4. Compressor:
   a. Fully hermetic type, internally protected.
   b. Factory rubber shock mounted and internally spring mounted for vibration isolation.
   c. Equipped with a factory installed crankcase heater to minimize liquid refrigerant accumulation in compressor during shutdown and prevent refrigerant dilution of oil.
5. Coils:
   a. Evaporator and condenser coils shall have fins mechanically bonded to seamless tubes with all joints brazed.
   b. Tube sheet openings shall be belled to prevent tube wear.
   c. Evaporator coil shall be of the full-face active design, degreased at the factory.
6. Heating Section:
   a. Heat Pump Heating Section:
      1) The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
      2) The refrigerant system shall have a pump-down cycle.
7. Refrigerant Components: Refrigerant circuit components shall include:
   a. Refrigerant feed system.
   b. Filter drier.
   c. Service gauge connections on suction, discharge and liquid lines.
8. Filter Section:
   a. Standard filter section shall consist of factory installed low velocity, disposable filters of commercially available sizes.
   b. Filter face velocity shall not exceed 500 fpm at nominal airflows.
9. Controls and Safeties:
   a. Unit Controls: Unit shall be complete with self-contained low voltage control circuit protected by a manually resettable circuit breaker.
   b. Fault Detection and Diagnostics: Provide an on-board fault detection and diagnostics system capable of identifying specific faults including alarm for low refrigerant charge, failed economizer function.
   c. Safeties:
      1) Unit shall incorporate a solid state compressor protector which provides reset capability at the space thermostat, should any of the following standard safety devices trip and shut off compressor:
         a) Compressor over temperature, overcurrent.
         b) Loss of charge/low pressure switch.
         c) Freezestat, evaporator coil.

d) High-pressure switch.

D. Operating Characteristics:
   a. Unit shall be capable of starting and running at 115°F ambient outdoor temperature per maximum load criteria of ARI Standard 210/240.
   b. Compressor with standard controls shall be capable of operation down to 25°F ambient outdoor temperature.
   c. Unit provided with fan time delay of 55 seconds to prevent cold air delivery before heat exchanger warms up.

2. Electrical Requirements: All unit power wiring shall enter unit cabinet at a single factory predrilled location.
3. Motors:
   a. Compressor motors shall be cooled by suction gas passing through motor windings and shall have line break thermal and current overload protection.
   b. Indoor blower motor shall have permanently lubricated bearings and inherent automatic reset thermal overload protection.
   c. Outdoor totally enclosed motor shall have permanently lubricated bearings, and inherent automatic reset thermal overload protection.
   d. Induced draft motor shall have permanently lubricated sealed bearings and inherent automatic reset thermal overload protection.
4. DOAS Unit Equipment Conformance List:

Medium Size Package Rooftop Unit (7-1/2 -25 ton) Equipment Requirements			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Unit Cabinet	Wall Construction	Single wall	X
		Double wall	
	Liner Options	Foil faced insulation	X
	Insulation	1/2” Insulation	
		1” insulation	X
	Maintenance Access	Tool required	
		Tool free	X
		Hinged panels	X
		Non-hinged panels	
	Condensate Pan	Plastic	
		Galvanized	X
		Stainless	
Supply Fan	Fan Access	Slide out cassette	X
		Non-slide out	
	Fan Wheel Construction	Fully welded fan wheels	X
	Motor type	ECM motor	
		Conventional	X
	Drive	Belt and sheaves	
		Direct	X
OSA Intake	Fixed OSA		X

Medium Size Package Rooftop Unit (7-1/2 -25 ton) Equipment Requirements			
	Economizer	Modulating dampers	
Relief Air	Relief provisions	Barometric damper only	
		Prop relief fan with damper	
		Return fan	
		Not required	
Compressor	Type of compressor	Scroll	X
		Digital Scroll	
		Variable Speed	
Cooling Efficiency		EER	See schedule
		IEER or SEER	See schedule
Evaporator	Coil Construction	Copper tubes/Aluminum fins	X
		Epoxy coated coil	
Condenser	Coil Construction	Copper tubes/Aluminum fins	X
		All aluminum coil	
		Copper tubes/Copper fins	
		Epoxy coated coil	
	Condenser fan	ECM type motor	X
		Constant speed motor	
Reheat	Reheat Coil	Modulating hot gas reheat coil	X
		Not required	
Filters	Filter type	2" MERV 13 pleated filter	X
		4" MERV 13 pleated filter	

Medium Size Package Rooftop Unit (7-1/2 -25 ton) Equipment Requirements (Continued)			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Controls	Economizer		
	Single Zone VAV		
	Full VAV Control		
	CO2 Sensor		
	OSA Monitor and controller		X
	Heat recovery control		
	Dehumidification Control		
	Factory digital controls	Zone controls by others	X
		Equip with zone controls and unit programming panel	
	BAS interface options	BACnet interface	X
		LonTalk Interface	
	Smoke Detector	Provide with unit	X
Electrical	Single point connection		X
	Powered convenience outlet	Receptacle	X

1. Other Features and Required Equipment: Provide the following with units.
   a. Roof Curb:
      1) Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.
      2) Seismically restrained spring isolating curb (See Section 230548 Vibration Seismic).
   b. Head Pressure Control Package: Consists of solid-state control and condenser coil temperature sensor to maintain condensing temperature between 90°F and 110°F at outdoor ambient temperatures down to -20°F by either condenser fan speed modulation or condenser fan cycling.
   c. Remote Control Panel: Panel shall be a decorative, indoor, wall mounted panel consisting of:
      1) Two stage heat/two stage cool thermostat.
      2) Automatic changeover.
      3) System switch with HEAT - COOL - AUTO - OFF settings.
      4) Fan switch with ON - AUTO settings.
      5) Indicator lights for HEAT - COOL - FAN operation.
      6) Three unused indicator lights for field use.

2.02 PROGRAMMABLE THERMOSTAT

A. Thermostat with 365-day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
   1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One or equal.

B. Minimum thermostat features shall include, but not limited to, the following:
   1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
   2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
   3. The setback override shall be activated by a single button, and deactivated on demand.
   4. Setpoints shall be adjustable from 35^0F to 99^0F, with a minimum 5°F adjustable deadband available.
   5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75^0F and heating setpoint of 70^0F. Initial unoccupied mode cooling setpoint of 85^0F and heating setpoint of 55^0F

C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
   1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
   2. An Emergency Heat switch will be provided on the touch screen when set in heat pump mode.

D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.

E. Controls shall be capable of alternating compressor starting sequence with a built in lead-lag operating logic.
   1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.

F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
   1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.

G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries.

I. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surface, e.g. roof, is ready to receive work.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide layout drawings of units, locations and power requirements to electrical installer.

C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.

D. Mount rooftop unit on:
   1. Seismically restrained spring vibration isolation curb. Install with top surface of roof mounting frame level.
   2. Or, factory built roof mounting frame where vibration will not be perceptible to occupants. Install with top surface of roof mounting frame level.

E. Install 3" flexible duct connection at inlets and outlets of units.

F. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.
   1. Install manufacturer provided condensate “air-trap” where provided with each unit. Install trap per manufacturer’s instructions and install condensate piping as required by local code.

G. Control installers shall install thermostat and all wiring associated with control signals into the units.

H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

I. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 74 13 - PACKAGED HVAC UNITS (UP TO 25 TONS)

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Packaged unit
   2. Controls and control connections
   3. Electrical power connections
   4. Roof mounting frame and base

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic HVAC Materials and Methods

B. Section 230593: Testing, Adjusting and Balancing

C. Section 230700: Mechanical Insulation

D. Section 233113: Air Distribution

E. Division 26: Electrical

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 - Standards Handbook
      b. 210 - Laboratory Methods of Testing Fans
      c. 300 - Reverberant Room Method for Sound Testing of Fans
      d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500 - Test Method for Louvers, Dampers, and Shutters

2. American National Standards Institute (ANSI):
   a. 9 - Load Ratings and Fatigue Life for Ball Bearings
   b. 11 - Load Ratings and Fatigue Life for Roller Bearings
   c. 900 - Test Performance of Air Filter Units
3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
   a. 210/240 – Performance Rating of Unitary Air Conditioning & Air-Source Heat Pump Equipment
   b. 270 - Sound Rating of Outdoor Unitary Equipment
   c. 340/360 – Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 - Safety Code for Mechanical Refrigeration
   b. 193 – Method of Test for Determining the Air Leakage of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 - National Electrical Code
   b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
9. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values listed in this specification.

1.05 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.06 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for packaged units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 1.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.09 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 230500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 PACKAGED ROOFTOP HEATING/COOLING UNIT (UP TO 20 TONS)

A. General:
1. Outdoor rooftop mounted, electrically controlled heating and cooling unit. Unit shall discharge supply air downward or horizontally as shown on contract drawings.
2. Unit shall be rated in accordance with ARI Standards 210, 240 and 270. Designed in accordance with UL Standard 465.
3. Unit shall be designed to conform to ANSI/ASHRAE 15.

4. Unit shall be UL tested and certified in accordance with ANSI Z21.47 Standards and CSA or CGA certified as a total package.
5. Roof curb shall be designed to conform to NRCA Standards.
6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

B. Manufacturers: Carrier, Trane, Daikin, York, Lennox, Aaon, Engineered-Air, or equal.

C. Equipment:
1. General:
   a. Factory assembled, single piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A) and special features required prior to field start-up.
2. Unit Cabinet:
   a. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
   b. Insulation: See Table below.
   c. Cabinet panels shall be easily removable for servicing. See Table below.
   d. Filters will be accessible through a hinged access door, and will require no panel or screw removal.
   e. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
   f. Unit shall have a factory installed internal condensate drain trap made of a non-corrosive material, providing a minimum 3/4" connection.
3. Fans:
   a. Indoor blower (evaporator fan):
      1) Fan shall be direct or belt driven as specified here (See matrix below). If belt driven the drive shall include an adjustable pitch motor pulley.
      2) Bearings shall be sealed, permanently lubricated ball bearing type for longer life and lower maintenance.
   b. Indoor blower shall be made from steel with a corrosion resistant finish and shall be dynamically balanced.
   c. Outdoor (condenser) fan shall be of the direct driven propeller type and shall discharge air vertically upward.
4. Compressor:
   a. Fully hermetic type, internally protected.
   b. Factory rubber shock mounted and internally spring mounted for vibration isolation.
   c. Equipped with a factory installed crankcase heater to minimize liquid refrigerant accumulation in compressor during shutdown and prevent refrigerant dilution of oil.
5. Coils:
   a. Evaporator and condenser coils shall have fins mechanically bonded to seamless tubes with all joints brazed.
   b. Tube sheet openings shall be belled to prevent tube wear.
   c. Evaporator coil shall be of the full-face active design, degreased at the factory.

6. Heating Section:
   a. Heat Pump Heating Section:
      1) The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
      2) The refrigerant system shall have a pump-down cycle.
7. Refrigerant Components: Refrigerant circuit components shall include:
   a. Refrigerant feed system.
   b. Filter drier.
   c. Service gauge connections on suction, discharge and liquid lines.
8. Filter Section:
   a. Standard filter section shall consist of factory installed low velocity, disposable filters of commercially available sizes.
   b. Filter face velocity shall not exceed 500 fpm at nominal airflows.
9. Controls and Safeties:
   a. Unit Controls: Unit shall be complete with self-contained low voltage control circuit protected by a manually resettable circuit breaker.
   b. Fault Detection and Diagnostics: Provide an on-board fault detection and diagnostics system capable of identifying specific faults including alarm for low refrigerant charge, failed economizer function.
   c. Safeties:
      1) Unit shall incorporate a solid-state compressor protector which provides reset capability at the space thermostat, should any of the following standard safety devices trip and shut off compressor:
         a) Compressor over temperature, overcurrent.
         b) Loss of charge/low pressure switch.
         c) Freeze stat, evaporator coil.
         d) High-pressure switch.

D. Operating Characteristics:
   a. Unit shall be capable of starting and running at 115°F ambient outdoor temperature per maximum load criteria of ARI Standard 210/240.
   b. Compressor with standard controls shall be capable of operation down to 25°F ambient outdoor temperature.
   c. Unit provided with fan time delay of 55 seconds to prevent cold air delivery before heat exchanger warms up.
2. Electrical Requirements: All unit power wiring shall enter unit cabinet at a single factory predrilled location.
3. Motors:
   a. Compressor motors shall be cooled by suction gas passing through motor windings and shall have line break thermal and current overload protection.
   b. Indoor blower motor shall have permanently lubricated bearings and inherent automatic reset thermal overload protection.
   c. Outdoor totally enclosed motor shall have permanently lubricated bearings, and inherent automatic reset thermal overload protection.

d. Induced draft motor shall have permanently lubricated sealed bearings and inherent automatic reset thermal overload protection.

4. Small Package Rooftop Unit (1-1/2 -5 ton) Equipment Conformance List: The scheduled units within this size category shall be configured with the following selected feature options.

Small Package Rooftop Unit (1-1/2 – 5 ton) **Equipment Requirements**			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Unit Case	Wall Construction	Single wall	X
		Double wall	
	Liner options	Foil faced insulation	X
	Insulation	1/2” Insulation	X
		1” insulation	
	Maintenance Access	Tool required	X
		Tool free	
		Hinged panels	
		Removable panels	X
	Condensate Pan	Plastic	
		Galvanized	X
		Stainless	
Supply Fan	Fan Wheel Construction	Fully welded fan wheels	X
		Slot and tab wheel construction	
	Motor Type	ECM motor	
		Conventional	X
	Drive	Belt and sheaves	X
		Direct	
Relief Air	Relief provisions	Barometric damper only	X
		Prop relief fan with damper	

Small Package Rooftop Unit (1-1/2 – 5 ton) Equipment Requirements			
		Return fan	
Economizer		Fixed OSA damper	X

Small Package Rooftop Unit (1-1/2 – 5 ton) Equipment Requirements (Continued)			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Compressor	Type of compressor	Scroll	X
		Digital Scroll	
		Variable speed	
Cooling Efficiency		SEER	See schedule
Evaporator	Coil Construction	Copper tubes/Aluminum fins	X
		Copper tubes/Copper fins	
		Epoxy coated Cu/Al coil	
Condenser	Coil Construction	Copper tubes/Aluminum fins	X
		Copper tubes/Copper fins	
		Coated condenser coil	
Reheat	Reheat Coil	Modulating hot gas reheat coil	
		Not required	X
Filters	Filter Type	1” filter	
		2" MERV 8 pleated filter	X
		2" MERV 13 pleated filter	
		4" MERV 13 pleated filter	

Small Package Rooftop Unit (1-1/2 – 5 ton) Equipment Requirements (Continued)			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Controls	Economizer	Full integrated 100% OSA economizer	
	Single Zone VAV controls		
	24/7 Programmable Thermostat		X
	CO2 Sensor		
	Factory Digital Controls	Zone control by others	X
		Supply with zone control and interface panel	
	BAS Interface Options	BACnet interface	X
		LON Interface	
	Smoke Detector	Provide with unit	
Electrical	Single Point Connection		X
	Convenience outlet	Receptacle	X

5. Medium Size Package Rooftop Unit (7-1/2 -25 ton) Equipment Conformance List: The scheduled units within this size category shall be configured with the following selected feature options.

Medium Size Package Rooftop Unit (7-1/2 -25 ton) Equipment Requirements			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Unit Cabinet	Wall Construction	Single wall	X
		Double wall	
	Liner Options	Foil faced insulation	X
	Insulation	1/2” Insulation	
		1” insulation	X

Medium Size Package Rooftop Unit (7-1/2 -25 ton) **Equipment Requirements**			
	Maintenance Access	Tool required	
		Tool free	X
		Hinged panels	X
		Non-hinged panels	
	Condensate Pan	Plastic	
		Galvanized	X
		Stainless	
Supply Fan	Fan Access	Slide out cassette	X
		Non-slide out	
	Fan Wheel Construction	Fully welded fan wheels	X
	Motor type	ECM motor	
		Conventional	X
	Drive	Belt and sheaves	
		Direct	X
OSA Intake	Fixed OSA		
	Economizer	Modulating dampers	X
Relief Air	Relief provisions	Barometric damper only	
		Prop relief fan with damper	X
		Return fan	
Compressor	Type of compressor	Scroll	X
		Digital Scroll	
		Variable Speed	
Cooling Efficiency		EER	See schedule
		IEER or SEER	See schedule

Medium Size Package Rooftop Unit (7-1/2 -25 ton) **Equipment Requirements**			
Evaporator	Coil Construction	Copper tubes/Aluminum fins	X
		Epoxy coated coil	
Condenser	Coil Construction	Copper tubes/Aluminum fins	X
		All aluminum coil	
		Copper tubes/Copper fins	
		Epoxy coated coil	
	Condenser fan	ECM type motor	X
		Constant speed motor	
Reheat	Reheat Coil	Modulating hot gas reheat coil	X
		Not required	
Filters	Filter type	2" MERV 8 pleated filter	X
		4" MERV 13 pleated filter	

Medium Size Package Rooftop Unit (7-1/2 -25 ton) **Equipment Requirements (Continued)**			
Component	**Feature**	**Specification Options**	**Specified Alternative**
Controls	Economizer	Fully integrated economizer controls	X
	Single Zone VAV		
	Full VAV Control		X
	CO2 Sensor		X
	OSA Monitor and controller		X
	Heat recovery control		

Medium Size Package Rooftop Unit (7-1/2 -25 ton) **Equipment Requirements (Continued)**			
	Dehumidification Control		
	Factory digital controls	Zone controls by others	X
		Equip with zone controls and unit programming panel	
	BAS interface options	BACnet interface	X
		LonTalk Interface	
	Smoke Detector	Provide with unit	X
Electrical	Single point connection		X
	Powered convenience outlet	Receptacle	X

6. Other Features and Required Equipment: Provide the following with units.
   a. Roof Curb:
      1) Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.

2) Seismically restrained spring isolating curb (See Section 230548 Vibration Seismic).

b. Head Pressure Control Package: Consists of solid-state control and condenser coil temperature sensor to maintain condensing temperature between 90°F and 110°F at outdoor ambient temperatures down to -20°F by either condenser fan speed modulation or condenser fan cycling.

c. Remote Control Panel: Panel shall be a decorative, indoor, wall mounted panel consisting of:
   1) Two stage heat/two stage cool thermostat.
   2) Automatic changeover.
   3) System switch with HEAT - COOL - AUTO - OFF settings.
   4) Fan switch with ON - AUTO settings.
   5) Indicator lights for HEAT - COOL - FAN operation.
   6) Three unused indicator lights for field use.

2.02 PROGRAMMABLE THERMOSTAT

A. Thermostat with 365-day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
   1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One or equal.

B. Minimum thermostat features shall include, but not limited to, the following:
   1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
   2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
   3. The setback override shall be activated by a single button, and deactivated on demand.
   4. Setpoints shall be adjustable from 35^0F to 99^0F, with a minimum 5°F adjustable deadband available.
   5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75^0F and heating setpoint of 70^0F. Initial unoccupied mode cooling setpoint of 85^0F and heating setpoint of 55^0F

C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
   1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
   2. An Emergency Heat switch will be provided on the touch screen when set in heat pump mode.

D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.

E. Controls shall be capable of alternating compressor starting sequence with a built in lead-lag operating logic.
   1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.

F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
   1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.

G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries.

I. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surface, e.g. roof, is ready to receive work.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide layout drawings of units, locations and power requirements to electrical installer.

C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.

D. Mount rooftop unit on:
   1. Seismically restrained spring vibration isolation curb. Install with top surface of roof mounting frame level.

2. Or, factory built roof mounting frame where vibration will not be perceptible to occupants. Install with top surface of roof mounting frame level.

E. Install 3" flexible duct connection at inlets and outlets of units.

F. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.
1. Install manufacturer provided condensate “air-trap” where provided with each unit. Install trap per manufacturer’s instructions and install condensate piping as required by local code.

G. Control installers shall install thermostat and all wiring associated with control signals into the units.

H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

I. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 81 30 - MINI-SPLIT AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Split air conditioning unit.
   2. Controls and control connections.
   3. Electrical power connections.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods

B. Section 23 0593: Testing, Adjusting and Balancing

C. Section 23 0716: Equipment Insulation

D. Section 23 0900: Building Automation System (BAS) Controls

E. Section 23 2300: Refrigerant Piping Systems

F. Section 23 3113: Air Distribution

G. Division 26: Electrical

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 - Standards Handbook
      b. 210 - Laboratory Methods of Testing Fans for Rating
   2. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
      a. 210 - Unitary Air-Conditioning Equipment
      b. 270 - Sound Rating of Outdoor Unitary Equipment
   3. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
   4. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
      a. 70 - National Electrical Code
      b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
      c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
   5. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
   6. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
   7. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values required by the local energy code.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.
   1. Provide a table listing:
      a. Items being submitted.
      b. Equipment tag.
      c. The acoustical test standard used.
      d. Acoustical performance in octave band format ranging from 63Hz to 8000Hz at design operating conditions.
      e. Installed operating CFM range.
      f. Installed static pressure expectations.
      g. Reference to the mechanical drawing sheet and room number to identify location.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.

Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.08 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

C. Provide five (5) year warranty on compressors.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM AIR CONDITIONING SYSTEM WITH INDOOR FAN COIL

A. Manufacturers: Mitsubishi, LG, Daikin, Carrier or equal.

B. Indoor Fan Coil Unit
   1. General:
      a. Factory fabricated wall or ceiling mounted fan coil units designed for ductless application of the size, type configuration and capacity as scheduled on the drawings.
      b. Units shall be self-contained, factory assembled and pre-wired.
      c. All pressure drops, motor horsepowers and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
      d. Manufacturers unable to meet this criterion will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the

specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.

e. Units shall be provided with factory welded mounting clips for mounting of units.

f. Sound power levels must be measured in accordance with AMCA 300-2008 or calculated in accordance with AMCA 301-2014

1) Inlet, discharge, and radiated sound power levels must not exceed the octave band limits scheduled on the project drawings under design operating conditions.

2. Unit Casing: Cabinet and grilles shall be zinc-coated bonderized steel finished with baked enamel paint or powdered coated finish. Grilles may be high-impact plastic.

3. Fan Assembly: Fan shall be direct drive with forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel. Rotating assembly shall provide a rigid support for motor and fan assembly. Assembly shall be accessible and entire assembly shall be removable for maintenance.

4. Motors: Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection or electrically commutated (EC). Fan motor to be multi-speed as specified on Drawings.

5. Coils: Coils shall be copper tube with ARI certified and of the same manufacturer as the unit to insure proper fit and quality mechanical bond. No exposed copper shall show between fins. Coils drip pan shall be galvanized steel coated with closed cell fire retardant foam insulation. A secondary drip pan shall be included under the coil header.

6. Filter Section: Filters shall be factory supplied cleanable filter or one-inch thick pleated.

7. Electrical: Unit electrical power shall be 115 volts, 1 phase, 60 hertz, or as specified on Drawings.

C. Outdoor Condensing Unit:

1. General: Provide remote outdoor air conditioning compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high- and low-pressure switches, accumulator, and thermostatic expansion valve.

2. Unit Cabinet: Galvanized steel, bonderized, and coated with powder coat paint.

3. Condenser Fans: Direct drive propeller type, discharging upward. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Condenser fan openings to be equipped with PVC-coated steel wire safety guards. Fan blades to be statically and dynamically balanced.

4. Coil: Aluminum fins mechanically bonded to copper tubes.

5. Refrigerant Components: Liquid tube shutoff valve with sweat connection, suction tube shutoff valves with sweat connection, refrigerant, accumulator, and reversing valve. An internal pressure relief valve to provide high-pressure protection to the refrigerant system.

6. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal PTC-type overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit. A crankcase heater shall be factory mounted on the outside of the compressor.
7. Electrical: Unit electrical power shall be 208/230 volts, 1 phase, 60 hertz, or as specified on Drawings. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.

D. Controls:
1. Unit shall have a factory wired temperature controller to perform input functions necessary to operate the system.
2. The controller shall consist of an on/off switch, thermostat setting, timer mode, high/medium/low fan speed, test run switching and check mode switching. Provide with 365-day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.
3. Temperature changes shall be by 2□F increments with a range of 65 - 87□F (minimum).
4. The control system shall consist of two (2) microprocessors interconnected by a single non-polar two wire cable.
5. Wiring shall run direct from the indoor unit to the controller with no splices.
6. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.
7. Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room.
8. The control voltage from the controller to the indoor unit shall be 12 volts, DC.
9. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.
10. The system shall be capable of automatic restart when power is restored after power interruption.
11. The system shall include self-diagnostics including total hours of compressor run time.
12. The microprocessor within the wall mounted remote controller shall provide automatic cooling, display set point and room temperature, 24 hour on/off timer so that automatic operation function display, check mode for memory of most recent problem.
13. Fan only operation shall be provided to permit room circulation when no cooling is required.
14. Compressor time delay to limit cycling.

E. Special Features:

1. Provide an internal condensate pump with interlock to unit operation in the event of malfunction.
2. Provide external electronic programmable thermostat.
3. Low ambient control capable of operating at 0ºF ambient temperature.

PART 3 - PRODUCTS

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive work.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide layout drawings of units, locations and power requirements to electrical installer.

C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.

D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.

E. Provide 4" high concrete pad extending 6" beyond edge of condensing unit on all sides. Attach condensing unit to concrete pad with concrete anchors and angle brackets.

F. Install condensate drain piping and traps in accordance with manufacturer's instructions and as shown on the Drawings.

G. Install copper refrigerant piping and insulate lines.

H. Install controller and all wiring associated with control signals between air handling unit and condensing unit. Conceal low voltage wiring in building structure, or inside the refrigerant pipe insulation, or in conduit.

I. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

J. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 81 45 - SPLIT HEAT PUMP UNITS

PART 1 - GENERAL

1.01 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Split air conditioning unit.
   2. Controls and control connections.
   3. Electrical power connections.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 23 0500: Basic HVAC Materials and Methods

B. Section 23 0593: Testing, Adjusting and Balancing

C. Section 23 0716: Equipment Insulation

D. Section 23 0900: Building Automation System (BAS) Controls

E. Section 23 2300: Refrigerant Piping Systems

F. Section 23 3113: Air Distribution

G. Division 26: Electrical

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 - Standards Handbook
      b. 210 - Laboratory Methods of Testing Fans for Rating
      c. 300 - Reverberant Room Method for Sound Testing of Fans
      d. 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500 - Test Method for Louvers, Dampers, and Shutters
   2. American National Standards Institute (ANSI):
      a. 9 - Load Ratings and Fatigue Life for Ball Bearings
      b. 11 - Load Ratings and Fatigue Life for Roller Bearings
      c. 900 - Test Performance of Air Filter Units
   3. Air-Conditioning, Heating and Refrigeration Institute (AHRI):
      a. 240 - Unitary Air-Source Heat Pump Equipment
      b. 270 - Sound Rating of Outdoor Unitary Equipment
   4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 15 - Safety Code for Mechanical Refrigeration
      b. 193 – Method of Test for Determining the Air Leakage of HVAC Equipment. All systems that move less than 3,000 cfm shall comply with less than 1.4% cabinet leakage rate.
   5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
   6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
      a. 70 - National Electrical Code
      b. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
      c. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems
   7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
   8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
   9. Minimum Efficiency: Minimum efficiencies shall meet or exceed the values required by the local energy code.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated,

motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.08 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

C. Provide five (5) year warranty on compressors.

PART 2 - PRODUCTS

2.01 SPLIT SYSTEM HEAT PUMP WITH INDOOR FAN COIL

A. Manufacturers: Trane, Carrier, Lennox, York, Rheem or equal.

B. Indoor Fan Coil Unit
1. General:
a. Factory fabricated fan coil units of the size, type configuration and capacity as scheduled on the drawings. Units shall be self-contained, factory assembled and pre-wired with condensate pump designed to operate with a two speed high efficiency heat pump.
b. All pressure drops, horsepowers and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must

have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.

c. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.

2. Unit Casing
   a. Unit shall be enameled, galvanized steel with minimum 1/2" 1.5 LB internal insulation. Insulation shall be attached with adhesive with all exposed edges coated to prevent erosion. All exposed metal inside and out shall be finished with at least one coat of gray enamel.
3. Fan Assembly
   a. Direct-driven, double-width fan wheels shall have forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel.
   b. Rotating assembly shall provide a rigid support for motor and fan assembly. Assembly shall be accessible and entire assembly shall be removable for maintenance.
   c. Motor shall be 3 speed permanent split capacitor type with sleeve type bearings and oversized oil reservoirs.
4. Coils
   a. Coils shall be ARI certified and of the same manufacturer as the unit to insure proper fit and quality. All coil casings shall be galvanized steel minimum or stainless steel. Copper tubes shall be a minimum thickness of 0.020 and return bends of minimum 0.035. Headers shall be non-ferrous seamless copper. Aluminum fins shall have a minimum thickness of 0.0080 and tubes shall be mechanically expanded into fin collars to provide permanent mechanical bond. No exposed copper shall show between fins.
   b. Coils shall be galvanized steel coated with closed cell fire retardant foam insulation.
5. Filter Section
   a. Filters shall be on inch thick pleated filter. Filter velocity shall be less than 500 FPM.
6. Unit Suspension
   a. For horizontally suspended units the manufacturer shall provide factory welded mounting clips for suspension of units. Clips to be capable of accepting 1/2" rod or isolators. Weights shown on plans are maximum allowable operating weights including water in coils.
7. Resistance Backup: Provide units with electric resistance backup heating capability. Coils to be of helix wound elements with limit controls and automatic reset.
8. Provide return air cabinet as specified on Drawings. Cabinet shall be constructed of heavy gage steel with baked enamel finish.
   a. Dampers: Outside air damper shall fail to closed position on shutdown.
   b. Damper Gaskets: Provide tight fitting dampers with edge gaskets.

c. Damper Operator: 24 volt operation.
d. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position when ambient air temperature exceeds return air temperature.
Controls shall prevent the operation of supplemental electric resistance heating when the heating load can be served by the heat pump alone.Controls shall prevent the operation of supplemental electric resistance heating when the heating load can be served by the heat pump alone.

C. Outdoor Condensing Unit:
1. General: Provide remote outdoor heat pump compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high and low pressure switches, accumulator, and thermostatic expansion valve.
2. Unit Cabinet: Galvanized steel, bonderized, and coated with powder coat paint.
3. Condenser Fans: Direct drive propeller type, discharging upward. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Motor to provide multispeed operation and enhanced low-speed efficiency and reduced noise. Fan blades to be statically and dynamically balanced. Condenser fan openings to be equipped with PVC-coated steel wire safety guards.
4. Coil: Aluminum fins mechanically bonded to copper tubes.
5. Refrigerant Components: Liquid tube shutoff valve with sweat connection, suction tube shutoff valves with sweat connection, R-401c refrigerant, accumulator, and reversing valve. An internal pressure relief valve to provide high-pressure protection to the refrigerant system.
6. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal PTC-type overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit.
7. Controls: Provide. Provide an electronic anti-short cycle control, a malfunction output signal to the indoor thermostat and an outdoor thermostat for auxiliary heat staging. Provide a compressor quick start kit. Provide auto-reset high and low-pressure switches to continuously monitor system operation and mechanical and electrical interlocks between the low and high-speed contactors to eliminate the potential of compressor motor burnout due to contactor malfunction.

2.02 SPLIT SYSTEM HEAT PUMP WITH WALL OR CEILING HUNG DUCTLESS INDOOR UNIT

A. Manufacturers: Mitsubishi, Sanyo, Carrier, or equal.

B. Indoor Fan Coil Unit
   1. General:
      a. Factory fabricated wall or ceiling mounted fan coil units designed for ductless application of the size, type configuration and capacity as scheduled on the drawings. Units shall be self-contained, factory assembled and pre-wired.
      b. All pressure drops, horsepowers and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
      c. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.
   2. Unit Casing:
      a. High Wall Unit: Cabinet shall be fully insulated with polystyrene inlet and discharge grilles.
      b. Ceiling Suspended Unit: Cabinet shall be zinc-coated bonderized steel finished with baked enamel paint. Inlet grilles shall be high-impact polystyrene.
   3. Fan Assembly:
      a. High Wall Unit: Tangential direct-drive blower with intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be standard.
      b. Fan shall be centrifugal blower with air intake in the bottom rear of the unit and discharge in the front.
   4. Motors:
      a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motor to be 3-speed.
   5. Coils:
      a. Coils shall be copper tube with ARI certified and of the same manufacturer as the unit to insure proper fit and quality mechanical bond. No exposed copper shall show between fins.
      b. Coils drip pan shall be galvanized steel coated with closed cell fire retardant foam insulation. A secondary drip pan shall be included under the coil header.
   6. Filter Section:
      a. Filters shall be factory supplied cleanable filter.
   7. Controls - Microprocessor based with the following functions:
      a. Automatic restart after power failure.
      b. Internal temperature sensing controls shall sense return air temperature.
      c. Indoor coil freeze protection.
      d. Dehumidification mode shall be provided to increase latent removal capability by modulating fan speed and set point temperature.

e. Fan only operation shall be provided to permit room circulation when no cooling is required.
f. Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during operating periods.
g. Compressor time delay to limit cycling.
h. Controls shall prevent the operation of supplemental electric resistance heating when the heating load can be served by the heat pump alone.

8. Special features:
   a. Provide an internal condensate pump with interlock to unit operation in the event of malfunction.
   b. Provide external electronic programmable thermostat for ceiling mounted units.

C. Outdoor Condensing Unit:
1. General: Provide remote outdoor heat pump compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high and low pressure switches, accumulator, and thermostatic expansion valve.
2. Unit Cabinet: Galvanized steel, bonderized, and coated with powder coat paint.
3. Condenser Fans: Direct drive propeller type, discharging upward. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Condenser fan openings to be equipped with PVC-coated steel wire safety guards.
4. Coil: Aluminum fins mechanically bonded to copper tubes.
5. Refrigerant Components: Liquid tube shutoff valve with sweat connection, suction tube shutoff valves with sweat connection, refrigerant, accumulator, and reversing valve. An internal pressure relief valve to provide high-pressure protection to the refrigerant system.
6. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal PTC-type overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit.
7. Controls: Provide an electronic anti-short cycle control, a malfunction output signal to the indoor thermostat and an outdoor thermostat for auxiliary heat staging. Provide a compressor quick start kit. Provide auto-reset high and low-pressure switches to continuously monitor system operation and mechanical and electrical interlocks between the low and high-speed contactors to eliminate the potential of compressor motor burnout due to contactor malfunction high condensing temperature protection. Systems diagnostics with matching fan coil.

2.03 PROGRAMMABLE THERMOSTAT

A. Thermostat with 365 day programmability that allows the building occupants to program the temperature setpoints for at least four periods within 24 hours. A minimum of 5 holidays shall be programmable for up to 5 years. Daylight savings shall be provided as a standard feature in the programming calendar.

1. Manufacturers: Honeywell VisionPRO 8000 Series, Honeywell Prestige THX 9000 Series, Honeywell TB7600 Series, Venstar ColorTouch T6000 Series, EnTouch Pro/One or equal.

B. Minimum thermostat features shall include, but not limited to, the following:
   1. The thermostat shall have a touch screen and shall display both room temperature and cooling and heating setpoints simultaneously, and shall indicate when cooling or heating and what stage is energized on the main screen.
   2. Programming may be accomplished at the thermostat, or via free software. The program shall have an override mode to provide comfort on demand while in an unoccupied period. The unoccupied override shall be adjustable by pushing an override button and selecting thirty minute increments, up to four hours.
   3. The setback override shall be activated by a single button, and deactivated on demand.
   4. Setpoints shall be adjustable from 35ºF to 99ºF, with a minimum 5°F adjustable deadband available.
   5. Dual setpoints shall be provided with the ability to individually set heating and cooling temperatures with adjustable heating and cooling setpoint limits. Initial occupied mode cooling setpoint of 75ºF and heating setpoint of 70ºF. Initial unoccupied mode cooling setpoint of 85ºF and heating setpoint of 55ºF.

C. The thermostat shall be capable of independently controlling an individual system, with up to three stages of heating and two stages of cooling, fan, and reversing valve.
   1. For heat pumps an adjustable auxiliary heat lockout temperature based on outdoor temperatures shall be provided.
   2. An Emergency Heat switch will be provided on the touch screen when set in heat pump mode.

D. The fan shall be programmable to operate continuously during occupied periods and in auto mode during unoccupied periods.

E. Controls shall be capable of alternating compressor starting sequence with a built in lead-lag operating logic.
   1. Equipment protection options shall be provided to prevent compressor short-cycling, and to limit the number of cycles per hour. These options shall be overridden for use with zoning systems.

F. Pre-Occupancy purge cycle that energizes the fan before the programmed occupancy time, adjustable up to three (3) hours in 15-minute increments.
   1. Configurable terminals shall be provided for remote indoor, remote outdoor or remote supply air temperature sensing.

G. Multiple security levels to limit access to programming and configuration and will allow for a custom passcode. The various security levels will allow controlled access to programming, unoccupied override, and thermostat mode.

H. All programming information, except time of day, shall reside in nonvolatile memory. During a power failure, the thermostat shall maintain its program indefinitely without the use of batteries. Wi-Fi capable and controlled through local wireless internet routers. The thermostat shall be capable of receiving an automated demand response signal from the local electrical utility, and automatically reset the cooling and heating setpoints during the demand event. When the demand event is terminated by the local electrical power utility, the thermostat will reset to normal occupied and unoccupied setpoints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive work.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide layout drawings of units, locations and power requirements to electrical installer.

C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.

D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.

E. Provide 4" high (minimum) concrete pad extending 6" beyond edge of condensing unit on all sides. Provide neoprene pad, minimum 3/4” by 2” x 2”, under each corner of condensing unit and secure to concrete pad with concrete wedge anchors, sheet metal screws and angle brackets.

F. Install 2" flexible duct connection at inlets and outlets of ducted units.

G. Install condensate drain piping and traps in accordance with manufacturer's instructions, per local code and as shown on the drawings.

H. Install manufacturer provided condensate “air-trap” where provided with each unit. Install trap per manufacturer’s instructions and install condensate piping as required by local code.

I. Install copper refrigerant piping and insulate lines.

J. Install thermostat and all wiring associated with control signals between air handling unit and condensing unit. Conceal low voltage wiring in building structure, or inside the refrigerant pipe insulation, or in conduit.

K. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

L. Install a new set of filters prior to final air balance and substantial completion.

3.03 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION

SECTION 23 84 13 - HUMIDIFIERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 23 0500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.02 SUMMARY

A. This Section includes the following humidifiers:
   1. Self-contained electric steam humidifiers.
   2. Steam jacketed dispersion tube injection humidifiers.

1.03 DEFINITION

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control, signaling power-limited circuits.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA-70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI/NFPA-70 – National Electrical Code.

C. Comply with AHRI 640 – Standard for Commercial and Industrial Humidifiers.

1.05 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which humidifiers will be attached.
   2. Size and location of initial access modules for acoustical tile.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.09 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.10 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 23 0500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.01 SELF-CONTAINED ELECTRIC STEAM HUMIDIFIERS

A. Refer to schedule on drawings for capacities and characteristics. Provide Type 316 stainless steel components where DI water is used as steam source.

B. Manufacturers: Neptronic, Carel, Nortec Humidifier, or equal.

C. General:

1. Provide self-contained, microprocessor controlled, wall mounted, electric resistive steam humidifiers as indicated, of size and capacity as scheduled. Electrode technology is not acceptable.
2. Humidifier shall meet the requirements of UL 998 and CSA C22.2 No.104 standards to comply with ETL certification.

D. Humidifier cabinet:
1. The humidifier casing shall be constructed of cold roll steel and stainless steel base with baked enamel finish to prevent rust.
2. For safety and security reasons, all components, electrical wiring and plumbing connections will not be exposed and must be contained within the cabinet of the unit.
3. The compartmentalized enclosure shall separate the plumbing, controls, and high-voltage sections, preventing heat, humidity or water transfer to the electrical sections and ensuring that the evaporation chamber remains isolated.
4. The plumbing compartment shall be equipped with a drip tray.
5. The front of the unit and the high voltage compartment shall have a lockable door to restrict access by unauthorized personnel.

E. Evaporation chamber:
1. Steam shall be generated in a stainless steel cleanable evaporation chamber.
2. The evaporation chamber shall be easily serviceable and removable from the unit. No tools are required during servicing.
3. The electronic level sensing assembly remains permanently fixed and separate from the evaporation chamber.
4. The heating elements and manual reset high temperature safety cut-out switch remain fixed in place, even as the evaporation chamber is removed for service cleaning.
5. The evaporation chamber shall have a water port designed to minimize the risk of blockage caused by sediment build-up. The water port will be easily detachable for servicing by means of a single quick connect assembly.

F. Immersion heating element(s):
1. Steam shall be generated by self-cleaning 800/825 Incoloy electric heating immersion elements.
2. The heating elements shall have a high expansion factor, minimizing mineral deposits and enabling most of them to break off and fall to the bottom of the chamber.

G. Water level control:
1. The water level detection system shall be self-cleaning, self-calibrating and equipped with a redundancy system, consisting of a high-resolution capacitive sensor and two fail-safe resistive sensors.
2. The humidifier must have the ability to sense foam and take a corrective action by going into drain cycle.

3. For safe temperature operation, the humidifier must have both an electronic temperature sensor inside the evaporation chamber and an external bimetallic temperature cut-off.

H. Water requirements:
1. The humidifier shall operate under all types of water including tap, deionized and reverse osmosis water, with no additional parts required.

I. Feed water:
1. The supply water to the unit shall be controlled by a quiet three port solenoid valve equipped with flow regulators, to supply water into the evaporation chamber, temper the hot water during a drain and clean the water level sensors.
2. To conserve energy, any hot water skimming during normal FILLING cycle is not acceptable.
3. The humidifier shall have a check valve in the fill water line to prevent backflow of hot contaminated water into the water supply system.
4. The humidifier shall have a pulsed fill mode to ensure that boiling does not stop while the humidifier is refilling, in order to maintain a constant steam output.

J. Drain:
1. The humidifier shall have a drain pump which provides a quick drain cycle, minimizing the down time.
2. The humidifier shall have four draining strategies: periodic full drain cycle, water dilute system, AFEC and configurable drain schedule, ensuring maximum energy efficiency, optimal steam output stability and minimal steam output interruptions.
3. To enhance safety and minimize energy consumption, the humidifier shall vary the drain time periods according to variations in water conditions.
4. After 72 hours of no demand, the humidifier will go into "Tank Rinse" or end of season mode, completely draining the unit to eliminate stagnant water.

K. Manual drain valve:
1. The humidifier shall be supplied with a manual drain valve which ensures that the unit can be drained even during a power failure.

L. Disconnect switch:
1. For safety reasons and to conform to local regulations, the humidifier shall have a built-in factory wired disconnect switch, to easily turn off the power without opening any access doors, ensuring that the power is off when accessing the electrical panels. An external disconnect switch is not required.

M. Controller:
1. The humidifier shall have an alphanumeric display and control module with 8 function buttons for fast configuration and operation.
2. The Idle Screen shall display common information including humidity demand, actual steam output and state of operation. It will also indicate special diagnostic parameters such as abnormal operation, time delays, etc.

3. The humidifier shall be programmable using the menu buttons to view and configure settings including control method, %R.H. set point, control signal type, and indication on number of actual service hours.
4. After the maximum number of hours of operation before servicing is due has been exceeded, the unit will display a need for servicing and the Status Display LED on the control panel will turn red.

N. SD card:
1. The unit shall be equipped with an SD card slot, to allow for simplified troubleshooting, by storing a history log of all humidifier trends and alarms.
2. The SD card shall allow for on-site firmware upgrades.

O. USB connection:
1. The unit shall be equipped with a USB port, to allow on-site firmware upgrades.

P. Scheduling system:
1. The humidifier shall be equipped with a configurable and independent scheduling system for unit operation and drain cycle, ensuring that the unit does not operate or drain when not necessary.

Q. User rights management:
1. The electronic controller shall be equipped with a user rights management system, which simplifies operation and protects the humidifier from unwanted access by displaying only the features associated to the type of user logged in.

R. Building automation systems:
1. The humidifier shall be equipped with communication protocols, including BACnet MS/TP, Modbus RTU, LonWorks, BACnet UDP/IP, or Modbus TCP/IP, for integration with a building management system (BMS).
2. These protocols shall be available via a plug-in module for simple upgrade of units already in the field.

S. Web services:
1. The humidifier shall be equipped with web services enabling humidifier parameter configuration, and access to diagnostics and other functions remotely using the internet.

T. Modulating control:
1. The control modulating signal shall be 0-10 VDC or 2-10 VDC, 4-20 mA or 0-20 mA to modulate 0-100% of the capacity.
2. The maximum output (SPAN) can be minimized by using the electronic "MAX OUTPUT" setting.
3. Modulation of all elements shall be achieved using silent SSR's with zero voltage crossing detection and firing. The SSR's will be backed up by an electro-mechanical contactor.
4. To avoid harmonics and peak electrical loads, Time Proportioning modulation using only electro- mechanical relays will not be acceptable.

U. Manifold: Stainless-steel tube with integral fan to discharge vapor directly into occupied space.

V. Accessories:
1. Humidistat: Wall or return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1. Install per manufacturer’s instructions.

B. Seal humidifier manifold duct penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install stainless-steel drain pan under each manifold mounted in duct.
1. Construct drain pans with connection for drain and insulated and complying with ASHRAE 62.1.
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.

E. Install manifold supply piping pitched to drain condensate back to humidifier.

F. Install drip leg upstream from steam trap a minimum of 12 inches (300 mm) tall for proper operation of trap.

G. Equipment Mounting:
   1. Install steam generators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3 Concrete.
   2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 Vibration Isolation for Piping, Ductwork, and Equipment.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Install piping adjacent to humidifiers to allow service and maintenance.
   2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Install piping from safety relief valves to nearest floor drain.

D. Ground equipment according to Division 26: Grounding and Bonding for Electrical Systems.

E. Connect wiring according to Division 26: Low-Voltage Electrical Power Conductors and Cables.

3.04 FIELD QUALITY CONTROL

A. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Section 017900 Demonstration and Training.

END OF SECTION

SECTION 26 00 00 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies requirements specifically applicable to the Work specified in Division 26. This Section is also referenced by related Work specified in other Divisions in addition to the provisions of Division 01.

1.02 WORK INCLUDED

A. Basic electrical requirements for all Division 26 Sections.

B. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete power distribution, auxiliary power production, lighting systems for the building and shall interface with all existing building systems affected by new construction.

C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and they shall coordinate their work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and raceways and are not to be scaled; all dimensions and existing conditions shall be inspected and verified by contractors at the building prior to start of any work.

D. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

E. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.03 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 26 Sections. Provide written reports on all tests.

1. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation
2. All work shall comply with the Americans with Disabilities Act (ADA).
3. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Owner's Representative for a decision before proceeding.
4. All work shall be incompliance with the following:
    a. Local, city, county and state codes and ordinances.
    b. Local Bureau of Buildings.
    c. Local Health Department.
    d. Local and State Fire Prevention Districts
    e. State Administrative Codes:
    f. Edit below to suit project state and years of codes currently in force. Verify information below matches information included on drawings.
    g. Provide in accordance with rules and regulations of the following:
5. California Building Codes enforced by the Authority Having Jurisdiction (AHJ).
    a. 2022 California Administrative Code, Part 1, Title 24 California Code of Regulations (CCR).
    b. 2022 California Building Code (CBC), Part 2, Title 24 CCR (2021 International Building Code with California Amendments).
    a. 2022 California Electrical Code (CEC), Part 3, Title 24 CCR (2020 National Electrical Code with California Amendments).
    c. 2022 California Mechanical Code (CMC) Part 4, Title 24 CCR (2021 Uniform Mechanical Code with California Amendments).
    d. 2022 California Plumbing Code (CPC), Part 5, Title 24 CCR (2021 Uniform Plumbing Code with California Amendments).
    e. 2022 California Building Energy Efficiency Standards, Part 6, Title 24 CCR.
    b. 2022 California Fire Code, Part 9, Title 24 CCR (2021 International Fire Code with California Amendments).
    f. 2022 California Green Building Standards Code (CALGreen), Part 11, Title 24 CCR.
    g. 2019 California Referenced Standards, Part 12, Title 24 CCR.
    h. Title 19 CCR Public Safety, State Fire Marshal Regulations.
6. Federal Building Codes enforced by the Authority Having Jurisdiction (AHJ):
    a. 2022 International Building Code (IBC).
    b. 2021 International Mechanical Code (IMC)
    c. 2021 International Plumbing Code (IPC)
    d. 2021 International Fire Code (IFC).
    e. 2021 International Energy Conservation Code (IECC).
    f. 2022 National Electrical Code (NEC)

1.04 CYBERSECURITY PROTECTION

A. For all installed systems that have internet connectivity, including but not limited to controls, monitoring, metering, sensors, or other remote access capabilities, the General Contractor is responsible to request from its subcontractors a cybersecurity risk mitigation plan. All cybersecurity risk mitigation plans shall be coordinated with the owner to verify functionality and compatibility with the owner's network architecture and topology. Cybersecurity risks to be mitigated include intrusion, remote access, viruses, spy-ware, and malware. Put in-place and in-use effective protection and homogenous policies for infrastructure, servers, workstations, controllers, network connected equipment, internet connected systems/devices, WiFi devices, IOT devices and mobile devices. Where relevant and applicable, apply the requirements of ISO/IEC 27000 Series of Standards relating to "Information Technology - Security Techniques".

B. For any "highly secure environments" identified by the owner, implement relevant jurisdiction-specific standards to be performed by an accredited Information Security advisor.

C. Coordinate with other divisions as applicable.

1.05 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.06 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Coordinate with other divisions work to provide electrical service as required to operate all equipment and devices under this Division of work.

D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for access.

E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 40 for rough-in requirements.

F. Coordinate electrical equipment and materials installation with other building components.

G. Verify all dimensions by field measurements.

H. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

J. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

K. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials. Contractor to provide for all cutting and patching required for installation of this work unless otherwise noted.

L. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.

M. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components.

N. Coordinate the installation of electrical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

O. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

P. All materials located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified when requested by the AHJ. If installed products are found to be not in compliance with the above, they shall be replaced at the contractor's expense.

Q. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.07 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:
1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive; also called "variable-frequency drive" (VFD).
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. cd: Candela, the SI fundamental unit of luminous intensity.
17. CO/ALR: Copper-aluminum, revised.
18. COPS: Critical operations power system.
19. CU or Cu: Copper.
20. CU-AL or AL-CU: Copper-aluminum.
21. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.

22. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
23. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
24. dBm: Decibel absolute power with respect to 1 mW.
25. DC or dc: Direct current.
26. DCOA: Designated critical operations area.
27. DDC: Direct digital control (HVAC).
28. EGC: Equipment grounding conductor.
29. ELV: Extra-low voltage.
30. EMF: Electromotive force.
31. EMI: Electromagnetic interference.
32. EPM: Electrical preventive maintenance.
33. EPS: Emergency power supply.
34. EPSS: Emergency power supply system.
35. ESS: Energy storage system.
36. EV: Electric vehicle.
37. EVPE: Electric vehicle power export equipment.
38. EVSE: Electric vehicle supply equipment.
39. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
40. FLC: Full-load current.
41. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.
42. ft: Foot.
43. ft-cd: Foot-candle, the antiquated U.S. Standard unit of illuminance, equal to one international candle measured at a distance of one foot, which was superseded in 1948 by the unit "footcandle" after the SI unit candela (cd) replaced the international candle; see "fc,"
44. GEC: Grounding electrode conductor.
45. GFCI: Ground-fault circuit interrupter.
46. GFPE: Ground-fault protection of equipment.
47. GND: Ground.
48. HACR: Heating, air conditioning, and refrigeration.
49. HDPE: High-density polyethylene.
50. HID: High-intensity discharge.
51. HP or hp: Horsepower.
52. HVAC: Heating, ventilating, and air conditioning.
53. Hz: Hertz.
54. IBT: Intersystem bonding termination.

55. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
56. IP: Ingress protection rating (enclosures); Internet protocol (communications).
57. IR: Infrared.
58. IS: Intrinsically safe.
59. IT&R: Inspecting, testing, and repair.
60. ITE: Information technology equipment.
61. kAIC: Kiloampere interrupting capacity.
62. kcmil or MCM: One thousand circular mils.
63. kV: Kilovolt.
64. kVA: Kilovolt-ampere.
65. kVAr or kVAR: Kilovolt-ampere reactive.
66. kW: Kilowatt.
67. kWh: Kilowatt-hour.
68. LAN: Local area network.
69. lb: Pound (weight).
70. lbf: Pound (force).
71. LCD: Liquid-crystal display.
72. LCDI: Leakage-current detector-interrupter.
73. LED: Light-emitting diode.
74. Li-ion: Lithium-ion.
75. lm: Lumen, the SI derived unit of luminous flux.
76. LNG: Liquefied natural gas.
77. LP-Gas: Liquefied petroleum gas.
78. LRC: Locked-rotor current.
79. LV: Low voltage.
80. lx: Lux, the SI derived unit of illuminance equal to one lumen per square meter.
81. m: Meter.
82. MCC: Motor-control center.
83. MDC: Modular data center.
84. MG set: Motor-generator set.
85. MIDI: Musical instrument digital interface.
86. MLO: Main lugs only.
87. MV: Medium voltage.
88. MVA: Megavolt-ampere.
89. mW: Milliwatt.
90. MW: Megawatt.
91. MWh: Megawatt-hour.
92. NC: Normally closed.
93. Ni-Cd: Nickel-cadmium.
94. Ni-MH: Nickel-metal hydride.
95. NIU: Network interface unit.
96. NO: Normally open.
97. NPT: National (American) standard pipe taper.
98. NRTL: Nationally Recognized Testing Laboratory, including UL and/or ETL.
99. OCPD: Overcurrent protective device.

100. ONT: Optical network terminal.
101. PC: Personal computer.
102. PCS: Power conversion system.
103. PCU: Power-conditioning unit.
104. PF or pf: Power factor.
105. PHEV: Plug-in hybrid electric vehicle.
106. PLC: Programmable logic controller.
107. PLFA: Power-limited fire alarm.
108. PoE: Power over Ethernet.
109. PV: Photovoltaic.
110. PVC: Polyvinyl chloride.
111. pW: Picowatt.
112. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
113. RMS or rms: Root-mean-square.
114. RPM or rpm: Revolutions per minute.
115. SCADA: Supervisory control and data acquisition.
116. SCR: Silicon-controlled rectifier.
117. SPD: Surge protective device.
118. sq.: Square.
119. SWD: Switching duty.
120. TCP/IP: Transmission control protocol/Internet protocol.
121. TEFC: Totally enclosed fan-cooled.
122. TR: Tamper resistant.
123. TVSS: Transient voltage surge suppressor.
124. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.
125. UL CCN: UL Category Control Number.
126. UPS: Uninterruptible power supply.
127. USB: Universal serial bus.
128. UV: Ultraviolet.
129. V: Volt, unit of electromotive force.
130. V(ac): Volt, alternating current.
131. V(dc): Volt, direct current.
132. VA: Volt-ampere, unit of complex electrical power.
133. VAR: Volt-ampere reactive, unit of reactive electrical power.
134. VFC: Variable-frequency controller.
135. VOM: Volt-ohm-multimeter.
136. VPN: Virtual private network.
137. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
138. W: Watt, unit of real electrical power.
139. Wh: Watt-hour, unit of electrical energy usage.
140. WPT: Wireless power transfer.
141. WPTE: Wireless power transfer equipment.
142. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:
   1. CR: Communications raceway.
   2. CR-GP: General-purpose communications raceway.
   3. CR-P: Plenum communications raceway.
   4. CR-R: Riser communications raceway.
   5. EMT: Electrical metallic tubing.
   6. EMT-A: Aluminum electrical metallic tubing.
   7. EMT-S: Steel electrical metallic tubing.
   8. EMT-SS: Stainless steel electrical metallic tubing.
   9. ENT: Electrical nonmetallic tubing.
   10. EPEC: Electrical HDPE underground conduit (thin wall).
   11. EPEC-A: Type A electrical HDPE underground conduit.
   12. EPEC-B: Type B electrical HDPE underground conduit.
   13. ERMC: Electrical rigid metal conduit.
   14. ERMC-A: Aluminum electrical rigid metal conduit.
   15. ERMC-S: Steel electrical rigid metal conduit.
   16. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
   17. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
   18. ERMC-SS: Stainless steel electrical rigid metal conduit.
   19. FMC: Flexible metal conduit.
   20. FMC-A: Aluminum flexible metal conduit.
   21. FMC-S: Steel flexible metal conduit.
   22. FMT: Steel flexible metallic tubing.
   23. FNMC: Flexible nonmetallic conduit. See "LFNC."
   24. HDPE: HDPE underground conduit (thick wall).
   25. HDPE-40: Schedule 40 HDPE underground conduit.
   26. HDPE-80: Schedule 80 HDPE underground conduit.
   27. IMC: Steel electrical intermediate metal conduit.
   28. LFMC: Liquidtight flexible metal conduit.
   29. LFMC-A: Aluminum liquidtight flexible metal conduit.
   30. LFMC-S: Steel liquidtight flexible metal conduit.
   31. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
   32. LFNC: Liquidtight flexible nonmetallic conduit.
   33. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
   34. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
   35. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
   36. OFR: Optical fiber raceway.
   37. OFR-GP: General-purpose optical fiber raceway.
   38. OFR-P: Plenum optical fiber raceway.
   39. OFR-R: Riser optical fiber raceway.
   40. PVC: Rigid PVC conduit.
   41. PVC-40: Schedule 40 rigid PVC conduit.
   42. PVC-80: Schedule 80 rigid PVC Conduit.
   43. PVC-A: Type A rigid PVC concrete-encased conduit.
   44. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.

45. RGS: See ERMC-S-G.
46. RMC: See ERMC.
47. RTRC: Reinforced thermosetting resin conduit.
48. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
49. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
50. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
51. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
52. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:
1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.

32. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: (high heat) Thermoset rubber, heat-resistant cable.
54. RHW: Thermoset rubber, moisture-resistant cable.
55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:
   1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
   2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
   3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
   4. SEOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
   5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
   6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
   7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
   8. SJEOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
   9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
   10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
   11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.
   12. SJOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
   13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
   14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
   15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
   16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
   17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.

18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Definitions:
1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.
2. Above Grade: Not buried in the ground and not embedded in concrete slab on ground.
3. Accessible: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.
4. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
5. Below Grade: Buried in the ground or embedded in concrete slab on ground.
6. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
7. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
8. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
9. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

10. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
11. Connect: Complete hook-up of item with required service
12. Designated Seismic System: A system component that requires design in accordance with Ch. 13 of ASCE/SEI 7 and for which the Component Importance Factor is greater than 1.0.
13. Direct Buried: Installed underground without encasement in concrete or other protective material.
14. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
    e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
    f. Device Box: A box with provisions for mounting a wiring device directly to the box.
    g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
    h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
    i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
    j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.

k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
l. Outlet Box: A box that provides access to a wiring system having pry-out openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
o. Raised-Floor Box: A floor box intended for use in raised floors.
p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

15. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
16. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
17. Expansion Joint: A mid-structure separation designed to relieve stress on building materials caused by building movement induced by any of the following: thermal expansion and contraction; wind sway; seismic events; static load deflection; or live load deflection. Expansion joint systems are used to bridge the gap and maintain building assembly functions while accommodating expected movements. Expansion joints also include transitions from an existing building to

a new building addition. Refer to structural design for expansion joint dimensional movements.

18. Explosion Proof Equipment (per National Electrical Code-Article 501): Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. Explosion proof motors are required for Class I, II or II applications regardless of Division or Group as defined in National Electrical Code – Article 501 and ANSI/ISA-12.20.01.
    a. Class I: Hazardous due to flammable gases or vapors are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
    b. Class II: Hazardous due to combustible or conductive dusts are present or may be present in quantities sufficient to produce explosive or ignitable mixture.
    c. Class III: Hazardous dues to ignitable fibers are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
    d. Division: The substance referred to by Class has a high probability (Division 1) or low probability (Division 2) of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.
    e. Group: Type of hazardous material in surrounding environment ranging from Group A flammable liquids to Group G combustible dusts
19. Exposed: Not installed underground or concealed
20. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.
    a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.
21. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
22. Install: To erect, mount and connect complete with related accessories.
23. Jacket: A continuous nonmetallic outer covering for conductors or cables.
24. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.

25. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
26. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
27. Noncombustible Material: A noncombustible material is a substance that will not ignite, burn, support combustion, or release flammable vapors when subject to fire or heat in compliance with ASTM E136 Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C. Examples of noncombustible materials include the following, but confirm compliance in manufacturer literature.
    a. Portland cement concrete, concrete, gypsum concrete (normally used in drywall or poured gypsum floor toppings), Portland cement stucco, Portland cement plaster, and gypsum plaster, gypsum wall board (sheetrock), and Type X gypsum wall board.
    b. Brick masonry, concrete block masonry, and ceramic tiles.
    c. Steel, stainless steel, galvanized steel, and other metals, except aluminum (aluminum is classified as limited-combustible), magnesium and magnesium alloys.
    d. Sheet glass, block glass, and uncoated glass fibers.
    e. Mineral wool and rock wool.
28. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
29. Provide: To supply, install and connect as specified for a complete, safe and operationally ready system.
30. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
31. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
32. Rough-In: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
33. Shall: An exhortation or command to complete the specified task including providing and installing work associated with task.
34. Sheath: A continuous metallic covering for conductors or cables.
35. Supply: To purchase, procure, acquire and deliver complete with related accessories.
36. Typical or Typ: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.
37. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.

38. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, which is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, which is rated above 30 V but not exceeding 1000 V.
    e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, which is rated about 1 kV but not exceeding 69 kV.
    f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, which is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

F. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.08 COORDINATION

A. The Drawings are diagrammatic and show the general arrangements of all electrical work and requirements to be performed. It is not intended to show or indicate all details which will be required for installation, as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting the work. It is the specific intention of this section that the contractor's scope of work shall include:
    1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications.
    2. Minor deviations from the electrical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange their work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with all other trades. Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor, and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Owner’s Representative, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner’s Representative of conflict.

F. Coordinate arrangement, mounting, and support of electrical equipment.
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

G. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

H. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames". The location needs to be coordinated with the architect prior to rough-in.

I. Coordinate sleeve selection and application of firestopping specified in Division 07.

J. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner's written permission.
   3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
      a. Exercising generators.
      b. Emergency lighting.

c. Elevators.
d. Fire-alarm systems.

K. Arrange to provide temporary electrical power in accordance with requirements specified in Division 01.

1.09 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than 10 days after notice to proceed. Agenda topics include, but are not limited to, the following:
1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.
6. Sustainability activities, including Measurement and Verification Plan.

1.10 SEQUENCING

A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.11 ACTION SUBMITTALS

A. Coordination drawings.

1.12 INFORMATIONAL SUBMITTALS

A. Electrical installation schedule.

B. Qualification statements.

C. Welding certificates.

D. Seismic-load performance certificates.

E. Delegated design drawings for structural masonry wall penetrations.

1.13 CLOSEOUT SUBMITTALS

A. Facility EPM program binders.

B. Operation and maintenance data.

C. Software and firmware operational documentation.

D. Software.

1.14 QUALITY ASSURANCE

A. Provide equipment and materials which conform to the standards effective as of the date of the Contract Documents as promulgated by the following bodies:
   1. Underwriters' Laboratories (UL).
   2. National Electrical Manufacturers' Association (NEMA).
   3. Electrical Testing Laboratories (ETL).
   4. American National Standards Institute (ANSI).
   5. Insulated Cable Engineers Association (ICEA).
   6. State adopted Electrical Code including local amendments applied to permit documentation.

B. Experience: Unless more stringent requirements are specified in other sections of Division 26, manufactured items shall have been installed and used, without modification, renovation, or repair, on other projects for not less than one year prior to the date of bidding for this project.
   1. All work shall include the following:
      a. Manufactured items and equipment shall be a current, cataloged product of the manufacturer.
      b. Replacement parts shall be readily available and stocked in the USA.

C. Special Inspections: Provide structural design and Special Inspections as required by local building codes and the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. All anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner’s Representative

D. Qualifications: Prepare and submit qualification statements for the following entities performing Work on Project:
   1. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 014000 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
   2. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including seismic modeling and analysis.
   3. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

4. Lighting Professional Engineer: Professional engineer possessing active qualifications in accordance with Section 014000 "Quality Requirements" and the following:
   a. Expertise in electrical engineering, lighting design, and structural requirements for exterior poles and standards.
   b. Lighting Certified (LC) Professional by the National Council on Qualifications for the Lighting Professions (NCQLP).
5. EPM Specialist: Recognized experts possessing the following qualifications in accordance with Section 014000 "Quality Requirements" and NFPA 70B:
   a. Technical Competence: Person should, by education, training, and experience, be well-rounded in all aspects of electrical maintenance.
   b. Administrative and Supervisory Skills: Person should be skilled in planning and development of long-range objectives to achieve specific results and should be able to command respect and solicit cooperation of persons involved in EPM Program development.
6. Welder: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," with training and certification in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M.
7. ERMC-S-PVC Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.
8. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable in accordance with electrical utility service provider's requirements.
   a. Medium-voltage cable Installer must be approved by owner.
9. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks in accordance with electrical utility service provider's requirements.
   a. Medium-voltage duct Installer must be approved by Owner.
10. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment in accordance with electrical utility service provider requirements.
    a. Medium-voltage equipment Installer must be approved by Owner.
11. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.
12. EVSE Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by EVSE manufacturer prior to starting installation.

13. Generator Set Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by generator set manufacturer prior to starting installation.
14. Lightning Protection System Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired UL-Listed Installer, UL Category Control Number OWAY, credentials or unexpired LPI Master Installer credentials prior to starting installation.
15. Theatrical Lighting Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by theatrical lighting manufacturers prior to starting installation.
16. Exterior Athletic Lighting Installers: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," and able to present unexpired certified Installer credentials issued by exterior athletic lighting manufacturer prior to starting installation.
17. Power Quality Specialist: Recognized experts possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction, and able to present unexpired NICET Level 4 credentials with documented experience in power quality testing for installations similar in complexity to this Project.
18. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
    a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
19. Medium-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
    a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
20. Power-Limited Electrical Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
    a. On-site power-limited testing supervisor must have BICSI Registered Communications Distribution Designer certification and documented training and experience with testing power-limited equipment in accordance with NETA testing standards.
21. Structural Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing structural concrete, seismic controls, and wind-load controls.

22. Outdoor Pole Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience in accordance with ASTM C1093 for foundation testing and inspections.
23. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
24. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with IES LM-5.

E. Certifications:
   a. Include the following information:
      1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
      3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
      4) Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
      5) Provide equipment manufacturer's written certification for each designated active electrical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction, or experience data as permitted by ASCE/SEI 7-10.
      6) Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-10.
      7) Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by qualified structural professional engineer.
   b. The following systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:
      1) Hangers and supports specified in Section 260529 "Hangers and Supports for Electrical Systems."
      2) Conduits and their mounting provisions specified in Section 260533.13 "Conduits for Electrical Systems."
      3) Boxes and their mounting provisions specified in Section 260533.16 "Boxes and Covers for Electrical Systems."

4) Seismic restraints specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
5) Equipment, accessories, and components specified in Section 262213 "Low-Voltage Distribution Transformers."
6) Equipment, accessories, and components specified in Section 262413 "Switchboards."
7) Equipment, accessories, and components specified in Section 262416 "Panelboards."
8) Cabinets, enclosures, racks, and their mounting provisions specified in Section 262716 "Electrical Cabinets and Enclosures."
9) Equipment, accessories, and components specified in Section 262733 "Power Distribution Units."
10) Equipment, accessories, and components specified in Section 262816 "Enclosed Switches and Circuit Breakers."
11) Luminaires, accessories, and components specified in Section 265000 "Lighting."
12) Luminaires, accessories, components, and dimmer racks specified in Section 265561 "Theatrical Lighting."

2. Wind-Load Performance Certificates: Provide special certification for systems and components designated on Drawings or in the Specifications to be subject to high wind exposure and impact damage.
   a. Include the following information:
      1) Provide equipment manufacturer's written certification for each designated system and component, stating that it will remain in place and operable following the design wind event and comply with requirements of authorities having jurisdiction.
      2) Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

1.15 FIELD CONDITIONS

A. Service Conditions for Electrical Power Equipment: Specified electrical power equipment must be suitable for operation under service conditions specified as usual service conditions in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards, except for the following:
   1. Exterior locations
      a. Exposure to significant solar radiation.
      b. Exposure to fumes, vapors, or dust.
      c. Exposure to explosive environments.
      d. Ambient temperature not exceeding 104 deg F (40 deg C).
      e. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
      f. Unusual transportation or storage conditions.
      g. Unusual grounding resistance conditions.
      h. Unusual space limitations.

1.16 TEMPORARY FACILITIES

A. Refer to Division 01 for the requirements of temporary power for construction and safety. Provide temporary electrical services as necessary during the construction period and as required to maintain operation of existing systems.

1.17 WARRANTIES

A. Refer to general terms and conditions, as well as warranties and obligations defined in Division 01 of the specifications that provide basic warranty requirements for the entire project.

B. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.

C. All equipment and systems shall be provided with a minimum one-year warranty, or longer, as defined in each subsequent specification section. Warranty shall include all parts, material, labor and travel.

D. Warranty Start Date: The start date for all warranty periods shall be defined as starting from the date of Substantial Completion which shall include the Certificate of Occupancy from the Authority Having Jurisdiction.

E. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

F. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

G. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the warranty period.

1.18 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by them and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in this work.

1.19 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. Operations and Maintenance (O&M) Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Owner's Representative complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder as well as in electronic form. Refer to Division 01 for additional requirements.

B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 26. Training is to be appropriate to the complexity of the equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated, and referenced in the training sessions.

1.20 RECORD DRAWINGS

A. Refer to Division 01 for additional record drawing requirements not specifically described below.

B. Before commencing installation, obtain an extra set of prints from Architect, marked "Record". Keep this set of Drawings at the job site at all times and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades.

C. Mark Drawings to indicate revisions to raceways; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground raceways; concealed equipment, dimensioned to column lines, and Change Orders.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Edit project Revit or AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit electronic and plots of Record Drawings at completion of project.

PART 2 - GENERAL

2.01 EXAMINATION OF DOCUMENTS

A. Before submitting a bid, visit the Project Site and become familiar with conditions which may be pertinent to, or affect the cost of, the electrical installation.

B. Become acquainted with the Work of other installers whose activities will adjoin or be affected by the electrical Work. Consult with these other installers and study all pertinent Drawings in order to coordinate the Work and to avoid conflicts, omissions and delays.

C. Before submitting a bid, examine all pertinent Contract Documents for electrical requirements which are not necessarily indicated on the electrical drawings and include in the bid a sum which is sufficient to cover the costs of these other requirements.

D. Should it be perceived that the Contract Documents do not sufficiently define the required electrical work, contact the Architect for clarification or further description. Failure to do this will be construed as evidence of an understanding of the required electrical systems and their installation.

E. Specifications, in general, describe quality and character of materials and equipment.

F. Drawings in general, are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.

2.02 PERMITS AND FEES

A. Contractor shall be responsible for obtaining and paying for all necessary electrical permits, fees, and inspections, including, but not limited to, building permits, planning permits, air quality management district permits, operating licenses, utility district fees, special district fees, environmental impact reports, and additional local permits and fees.

2.03 EXISTING FACILITIES

A. Examine the drawings and specifications of the completed work and inspect the site to establish the scope of demolition work and new work to be provided under this sections and clarification of the phasing of the work.

B. Based on project phasing and scheduling, demolition work will be taking place in and around existing areas that are to remain in service. Where the work under this section affects or interferes with the operation of any existing areas to remain in service, or portions of the work already in operation, provide all necessary work and material including premium pay, required to avoid shutdown of these areas during normal

operations. Obtain Owner's approval for shutdown, in writing, 48 hours prior to shut down.

2.04 UNIT PRICING

A. See Division 01 for Unit Pricing Requirements.

B. Included with unit price shall be the labor cost index.

C. In addition to those items noted in Division 01 provide unit pricing for the following:
   1. Electrical outlet with backbox, cover plate, and 20’ of raceway and wire.

2.05 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:
   1. Notification of Contractor's intent to request substitutions for convenience must be declared during the Electrical Preconstruction Conference so potential risks to system performance and construction schedule may be identified for Contractor's response in submission of the substitution request. Submission of requests for substitutions for convenience must meet the conditions and deadline specified in Section 012500 “Substitution Procedures” to receive approval.
   2. For electrical equipment and systems, substitutions for cause are considered major construction risks. If it is possible that Contractor may need to request substitutions for cause because of equipment unavailability, or inability to meet construction schedule because of lead time, Contractor must declare the possibility during the Electrical Preconstruction Conference to permit establishing a mitigation plan for minimizing risks to system performance and construction schedule.
   3. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
      a. The proposed substitution does not affect dimensions shown on drawings.
      b. The proposed substitution does not affect the electrical characteristics shown on the drawings.
      c. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
      d. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
      e. Maintenance and service parts available locally are readily obtainable for the proposed substitute.
   4. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.
   5. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

PART 3 - EXECUTION

3.01 CONSTRUCTION ADMINISTRATION

A. Substitutions
   1. Refer to other Sections of these Specifications for substitution requirements.

B. Submittals
   1. All submittals shall be provided in electronic format for review.
   2. All submittals associated within a single specification section shall be submitted as a single package. Piecemeal submittals will be rejected as incomplete.
   3. Re-submittals shall only include the requested resubmittal documentation. A complete resubmittal including approved equipment and materials will be rejected.
   4. If an error in the submittals is not detected during the review process, this does not grant the contractor permission to proceed in error. Regardless of any information contained in the submittals, the requirements of the drawings and specifications must be followed and are not waived or superseded by the submittal review. Any conflicting information shall be brought to the attention of the engineer and design team through the RFI process.
   5. Submittals for all installed items shall be included in final Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

C. Requests for Information (RFIs)
   1. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 1).
      a. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
      b. RFIs shall address single questions and related issues only.
      c. All RFIs shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to Owner’s Design Representative.
   2. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
      a. Project name.
      b. Project number.
      c. Date.
      d. Name of Contractor.
      e. Name of Architect [and Construction Manager].
      f. RFI number, numbered sequentially and unique.
      g. RFI subject.

h. Specification Section number and title and related paragraphs, as appropriate.
i. Drawing number and detail references, as appropriate.
j. Field dimensions and conditions, as appropriate.
k. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
l. Contractor's signature.
m. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
n. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

3. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response for each RFI, plus additional time for Architect and General Contractor to review and forward. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
   a. The following Contractor-generated RFIs will be returned without action:
   b. Incomplete RFIs or inaccurately prepared RFIs.
   c. RFIs submitted without indication of review and approval for submission by General Contractor.
   d. RFIs addressing multiple unrelated issues.
   e. Requests for approval of submittals.
   f. Requests for approval of substitutions.
   g. Requests for approval of Contractor’s means and methods.
   h. Requests for information already indicated in the Contract Documents.
   i. Requests for adjustments in the Contract Time or the Contract Sum.
   j. Requests for interpretation of Engineer’s actions on submittals.
   k. Engineer’s action may include a request for additional information, in which case Engineer’s time for response will date from time of receipt of additional information.

D. Installation Drawings
   1. Refer to other Sections of these Specifications for installation drawing requirements.

E. Project Record Documents
   1. Maintain Record Documents which clearly indicate variances from the specified systems, and which accurately locate all underground electrical conduits and structures.

3.02 EXAMINATION

A. Verification of Conditions:
   1. Field verify exact locations, dimensions, and routing of existing equipment.

2. Throughout the course of construction, verify that sufficient space will be available for the equipment and their required clearances to be installed. If conflict determined, contractor shall contact the design team for clarification on how to proceed prior to installation.

3.03 DRAWINGS

A. For purposes of clarity and legibility, the electrical Drawings are essentially diagrammatic. although the size and location of electrical equipment is drawn to scale wherever possible, make use of all data in all the Contract Documents, and verify this at the Project Site. Determine the exact location of conduits, outlets and equipment by the study of details, shop drawings and/or the Architect's directions.

B. The electrical Drawings show the required size and points of termination of the conduits and the quantity and size of the conductors within. However, the Drawings do not show all the necessary conduit routing. Install conduits in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep passageways and openings clear.

C. Locate outlets symmetrically with architectural elements, notwithstanding the fact that the locations shown of the electrical drawings may be distorted for clarity of representation.

D. The architectural Drawings take precedence over the electrical Drawings. Study the reflected ceiling plans and interior elevations to determine the exact location of lighting fixtures, wall-mounted devices and fixtures, etc. The Architect has taken a very active role in the placement of these items. Should there be a conflict between locations shown on the architectural and electrical drawings, contact the Engineer for clarification prior to rough-in.

3.04 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

C. Right of Way: Give way to piping systems installed at a required slope.

D. Equipment Dimensions: Provide equipment that fits the available space. Do not exceed dimensions indicated or shown without prior approval.

E. Workmanship shall be performed or supervised by licensed journeymen or master electrician and shall result in an installation consistent with the best practices of trades.

F. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

G. Coordinate the work between the various Electrical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor's cost. Coordinate wall and ceiling work with the General Contractor, and their subcontractors in locating lighting fixtures, wiring devices, disconnects, controllers, etc.

H. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.05 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

B. If the contractor must deviate from the manufacturer's recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.06 COORDINATION OF ELECTRICAL INSTALLATIONS

A. Electrical Contractor shall coordinate with all other divisions work to provide electrical services as required to operate all devices under this Division of work.

B. Installation of Electrical Connections: Furnish and install devices, conduit, and wire (except as may be otherwise indicated) to all other trades equipment in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.

C. Coordinate location of electrical devices and electrical connections with all other trades prior to rough-in. Any rework of installations required due to incorrect rough-in shall be corrected at no additional cost to the owner.

D. Divisions 21, 22, and 23 has responsibilities for electrically powered or controlled equipment which is specified in these related division specifications or scheduled on these related division Drawings. The specific division of responsibilities between these

divisions and Division 26 for furnishing or wiring this equipment is shown on the equipment schedule located on the drawing set and listed below:

1. Divisions 21, 22, and 23 Responsibilities:
    a. Motors: Furnish and install all motors necessary for mechanical equipment.
    b. Magnetic starters: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of equipment, also furnish and install the power wiring between starter and motor.
    c. Variable frequency drives: Provide all VFD's associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
    d. Disconnects: Provide the disconnects which are part of factory wired equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
    e. Controls: Divisions 21, 22, and 23 Contractor (including the Building Automation System (BAS) controls contractor is responsible for furnishing the following equipment in its entirety. This equipment includes but is not limited to the following:
        1) Additional control panels beyond what is identified on drawings shall be provided by BAS contractor in order to provide a complete control system at no additional cost to Owner. 120v wiring to these control panels shall be provided by BAS Contractor from nearest source panel.
        2) Control relays necessary for controlling equipment.
        3) Control transformers necessary for providing power to controls for equipment.
        4) Line voltage thermostats for controlling Division 23 equipment.
        5) Low or non-load voltage control components.
        6) Remote bulb thermostats.
        7) Non-life safety related valve or damper actuators.
        8) Float switches.
        9) Solenoid valves, EP and PE switches.
        10) Communications wiring and conduit between control devices and mechanical equipment.
        11) Refrigeration controls. (Division 26 provides power to refrigeration panels.)
        12) Raceways to support control cabling.
    f. Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.

1) Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with specified end switches for use by Division 28 in providing proof of closure.
2) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed by Division 23 but wired for damper control by Division 26.

g. Fire Sprinkler System: Division 23 is responsible for providing necessary controls including flow switches and alarm bells.
h. Specialized fire suppression systems: Division 23 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.

E. Division 26 Electrical Responsibilities:
a. Motors: Provide the power wiring for the motors from servicing panel to motor controller.
b. Magnetic starters: Except where magnetic starters are factory installed on factory assembled equipment, Division 26 is to install magnetic starters furnished by others and install the necessary power wiring to the starter and from the starter to the motor, unless otherwise noted on the drawings. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
c. Variable frequency drives: Physically mount all VFD's, which are not specified to be installed on factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by the factory. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to ensure that the drive is shutdown simultaneously with motor.
d. Disconnects: Provide all disconnects necessary for equipment which are not provided as part of factory wired equipment, unless otherwise noted on the drawings. Provide power wiring to all disconnects. In addition provide power wiring between equipment and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
e. Controls: Division 26 Contractor is responsible for providing power to control panels, control transformers, and control circuit outlets.
f. Building Automation System:
1) BAS Controls Contractor shall initiate and coordinate a meeting with the Electrical Contractor and General Contractor to coordinate all BAS component locations and wiring requirements prior to start of

construction. All additional costs associated with lack a coordinated shall be the responsibility of the BAS Contractor at no additional cost to the Owner.

2) Additional power requirements, including conduit and wiring, for additional or relocated control panels and devices shall be coordinated and the responsibility of the BAS Controls Contractor at no additional cost to Owner.

g. Fire/Smoke Dampers:
   1) Division 26 is responsible for power wiring to the damper.
   2) Where these dampers are part of an integrated smoke control system Division 28 is responsible for providing the duct\smoke detectors, for Division 23 installation in duct. Division 26 is responsible for all fire detection system wiring necessary to integrate dampers and related end switches into the system.
   3) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.

h. Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.

i. Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and its controls.

3.07 EXISTING FACILITIES

A. Based on project phasing and scheduling, demolition work will be taking place in and around existing areas that are to remain in service. Where the work under this section affects or interferes with the operation of any existing areas to remain in service, or portions of the work already in operation, provide all necessary work and material including premium pay, required to avoid shutdown of these areas during normal operations. Obtain Owner's approval for shutdown, in writing, 48 hours prior to shut down.

B. Existing electrical and signal facilities outside of the demolition area to remain in place and in service during demolition.

C. Where areas of existing facilities are indicated to be demolished or remodeled, relocate electric and signal system equipment, and reroute or replace conduit and wiring as required to conform with new use of the area and maintain operation of adjacent areas.

D. Unless specifically noted or otherwise indicated or directed, remove all existing electrical equipment in the areas to be demolished. Deliver all equipment removed, including lighting fixtures, to the Owner's representative.

E. Where remodeling of existing areas is indicated, provide all work indicated and required for a complete and operating facility. Where work is adjacent to existing fixtures or devices, provide matching products to present uniform appearance. Salvage demolished material and equipment and deliver to Owner as directed. Dispose of salvaged materials and equipment where so directed in writing by Owner. Patch all openings in existing walls or floors caused by removal of materials and/or equipment under this work.

3.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications.

B. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.

C. Provide new electrical materials and deliver them to the Project Site in unbroken packages.

D. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Conduit and equipment showing signs of rust shall be removed from site and replaced with new.

3.09 PREPARATION

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
   1. Submission of power system studies.
   2. Submission of specified coordination drawings.
   3. Submission of action submittals specified in Division 26.
   4. Orders placed for major electrical equipment.
   5. Arrival of major electrical equipment on-site.
   6. Preinstallation meetings specified in Division 26.
   7. Utility service outages.
   8. Utility service inspection and activation.
   9. Mockup reviews.
   10. Closing of walls and ceilings containing electrical Work.
   11. System startup, testing, and commissioning activities for major electrical equipment.
   12. System startup, testing, and commissioning activities for emergency lighting.
   13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
   14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.

15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

3.10 COORDINATION DRAWINGS

A. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

B. Coordination Drawings for Ceiling Areas: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 013100 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which equipment, luminaires, and suspension systems will be attached.
   3. Partitions and millwork that penetrate ceiling or extend to within 12 inch (300 mm) of plane of luminaires.
   4. Size and location of access panels on ceilings.
   5. Elevation, size, and route of sprinkler piping.
   6. Elevation, size, and route of plumbing piping.
   7. Elevation, size, and route of ductwork.
   8. Elevation, size, and route of cable tray.
   9. Elevation, size, and route of conduit.
   10. Elevation and size of wall-mounted and ceiling-mounted equipment.
   11. Moldings.
   12. Access panels.
   13. Sprinklers.
   14. Air inlets and outlets.
   15. Control modules.
   16. Luminaires.
   17. Communications devices.
   18. Speakers.
   19. Ceiling-mounted projectors.
   20. Security devices.
   21. Fire-alarm devices.
   22. Indicate clear dimensions for maintenance access in front of equipment.
   23. Indicate dimensions of fully-open access doors.

C. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

D. Coordination Drawings for Large Equipment Indoor Installations:
   1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
   2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
      a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
      b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
      c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.
   3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items shown and coordinated with each other, based on input from installers of the items involved:
      a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways and seismic bracing.
      b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
      c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

E. Coordination Drawings for Large Equipment Outdoor Installations:
   1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
      a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
      b. Indicate clear dimensions for fence gates and wall openings.
      c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
      d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
      e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways and seismic bracing.
      f. Dimensioned working clearances and dedicated areas around electrical equipment.

F. Coordination Drawings for Duct Banks:
   1. Show duct profiles and coordination with other utilities and underground structures.
   2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

3.11 DELEGATED DESIGN OF STRUCTURAL PENETRATIONS

A. Engage qualified structural professional engineer to design penetrations of structural masonry walls.

B. Delegated Design Drawings for Structural Masonry Wall Penetrations: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by elevations, sections, and other details, drawn to scale, signed and sealed by a qualified structural professional engineer, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Location and dimensions of structural members supporting wall.
   2. Location and dimensions of columns near penetrations.
   3. Location and dimension of headers and lintels.
   4. Doors and windows near penetrations.
   5. Location and dimensions of penetrating cuts.
   6. Sprinkler piping and sleeves.
   7. Plumbing piping and sleeves.
   8. Ductwork and sleeves.
   9. Cable tray and sleeves.
   10. Conduit and sleeves.
   11. Firestopping assemblies for rated penetrations.
   12. Structural supports for piping, ductwork, and conduit on both sides of wall.

C. Delegated Design Criteria: As depicted on Drawings.

3.12 ACCESS PANELS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Refer to Architectural Specifications for the required product Specification for each surface.

B. Exact size, number and location of access panels is not shown on Plans. Contractor is to submit schedule of access panels as well as a markup on architectural plans showing size and location of all panels for approval.

C. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted.

D. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

3.13 WATERPROOFING

A. Wherever electrical Work pierces waterproofing or waterproofing membranes, install it in an approved watertight manner.

3.14 CUTTING AND PATCHING

A. Provide core drilling, cutting and patching of existing construction and surfaces for the installation of electrical systems. Concrete, asphalt, or plaster surfaces which have been damaged by such drilling or cutting shall be patched and repaired to match the surrounding surface.

3.15 FIELD QUALITY CONTROL

A. At Project Completion:
   1. Test electrical loads and controls under full operating conditions and immediately replace defective electrical equipment, devices and workmanship at no cost to the Owner.
   2. Perform all standard electrical functional tests such as electrical insulation and ground resistance, or temperature rise, as well as the tests required in subsequent sections.

B. Administrant for Medium-Voltage Electrical Tests and Inspections:
   1. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.

C. Administrant for Low-Voltage Electrical Tests and Inspections:
   1. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.

D. Administrant for Power-Limited Electrical Tests and Inspections:
   1. Engage qualified power-limited electrical testing and inspecting agency to administer and perform tests and inspections.

E. Administrant for Structural Tests and Inspections:
   1. Engage qualified structural testing and inspecting agency to administer and perform tests and inspections.

F. Administrant for Field Tests and Inspections of Lighting Installations:
   1. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.

G. Closing-in of Work: Do not allow Electrical Work to be covered or enclosed until it has been observed by the Architect's Representative. Should unobserved Electrical Work be covered or enclosed, uncover it for observation and then make repairs as necessary to restore the Electrical Work and the Work of other affected installers to its original and proper condition, at no cost to the Owner.

3.16 ADJUST AND CLEAN

A. Keep the Project Site free from accumulations of electrical rubbish and debris. Remove such accumulations from the Project Site.

B. Thoroughly clean electrical equipment and materials of plaster, cement and other foreign materials and leave smooth, clean, and dry.

C. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect (Owner’s Representative).

3.17 CLOSEOUT ACTIVITIES

A. Development of Facility EPM Program
   1. Facility EPM Program must be developed by qualified EPM specialist.
   2. Conduct Facility EPM Program analysis in accordance with NFPA 70B recommendations.
      a. Renovation Projects:
         1) Facility diagrams must include connected existing equipment for entire facility where known. Areas of uncertainty should be clearly indicated.
         2) Obtain copies of existing operation and maintenance data and existing Facility EPM Program information from Owner.
         3) Facility EPM Program analysis should identify existing equipment that does not have available operation and maintenance data and should explain the Owner's risks because this equipment is not included in Facility EPM Program.
         4) Data for existing equipment outside scope of Project may be inserted in Facility EPM Program Binders without analysis.
         5) Data for existing equipment impacted by scope of Project should be analyzed and documented similar to Project's new equipment data as much as possible.
   3. Compile operation and maintenance data from Facility EPM Program analysis and submit updated Facility EPM Program Binders.

d) Include warranty and maintenance contract information.

6) Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:
   a) Include schedules of maintenance material items recommended to be stored at facility.
   b) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
   c) Include calibration and servicing data for each item.
7) Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:
   a) Include tables showing frequency of activities for each item.
   b) Include annual schedule with activities mapped to specific days of the year.
   c) Include exterior pole inspection and repair procedures.
8) Volume 8 - Inspection, Testing, and Repair (IT&R) Forms:
   a) As required.
9) Volume 9 - Inspection, Testing, and Repair (IT&R) Procedures:
   a) As required.
10) Volume 10 - Spare Parts List:
   a) Include list of all parts required to perform IT&R procedures.
   b) Identify quantities of which parts are recommended to be stored on-site.
   c) Include source contact information and budget cost for each item.
11) Volume 11 - Construction Project Closeout Record Documentation:
   a) Include records of power system studies and photometric studies.
   b) Include records of risk assessment studies.
   c) Include records of electrical system startup and commissioning activities.
   d) Include records of baseline inspections and tests.
   e) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
   f) Include records of baseline settings for adjustable equipment and devices.

5. Format of Facility EPM Program Binders Submittal:
   a. Complete Set: On USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
   b. Volumes 2 and 8: Reproducible hardcopy on archival quality, 28 lb (105 GSM), acid-free, bond paper.

B. Operation and Maintenance Data: Prepare and submit the following:
   1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:
      a. Emergency inverter System.

4. Organization of Facility EPM Program Binders:
   a. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EPM Program development.
   b. Referenced Standards: Content must comply with recommendations in NFPA 70B.
   c. General Characteristics:
      1) Volume 1 - Introduction:
         a) Summarize how Facility EPM Program Analysis was performed, how data were collected, and how volumes are organized.
         b) Describe Facility EPM Program and provide recommended policies and procedures for implementing the program and keeping it current.
         c) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EPM Program.
      2) Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:
         a) Include training requirements for employees and contractors.
         b) Include list of known facility hazards impacting IT&R activities.
         c) Include approval and permitting procedures for IT&R activities.
         d) Include incident emergency response procedures.
         e) Include emergency shutdown procedures.
         f) Include electrical disaster recovery procedures.
      3) Volume 3 - Operating Procedures for Electrical Equipment and Controls:
         a) Include copies of demonstration and training videos.
      4) Volume 4 - Facility Diagrams and Schedules:
         a) Include single-line diagrams.
         b) Include grounding and bonding diagrams.
         c) Include essential wiring diagrams.
         d) Include system communications diagrams (WAN, LAN, Wi-Fi, ERCES, MNS, etc.)
         e) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
         f) Include records of switchgear, switchboard, and panelboard schedules.
         g) Include time-current curves for overcurrent protective devices.
         h) Include list of load-current and overload-relay heaters with related motor nameplate data.
      5) Volume 5 - Inventory of Facility Equipment Using Electrical Power:
         a) Include simplified floor plans showing equipment locations.
         b) Identify critical equipment (electrical or otherwise).
         c) Include identifying designations and nameplate data.

2. Include the following information:
   a. Manufacturer's operating specifications.
   b. User's guides for software and hardware.
   c. Schedule of maintenance material items recommended to be stored at Project site.
   d. Detailed instructions covering operation under both normal and abnormal conditions.
   e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
   f. List of load-current and overload-relay heaters with related motor nameplate data.
   g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
   h. Manufacturer's instructions for setting field-adjustable components.
   i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
   j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
   k. Exterior pole inspection and repair procedures.
   l. Include copies of demonstration and training videos.

C. Software and Firmware Operational Documentation: Provide software and firmware operational documentation in Facility EPM Program Binders, including the following:
   1. Software operating and upgrade manuals.
   2. Names, versions, and website addresses for locations of installed software.
   3. Device address list.
   4. Printout of software application and graphic screens.
   5. Testing and adjusting of panic and emergency power features.
   6. For lighting controls, include the following:
      a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
      b. Operation of adjustable zone controls.

D. Software:
   1. Program Software Backup: Provide USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
   2. Provide to Owner upgrades and unrestricted licenses for installed and backup software, including operating systems and programming tools required for operation and maintenance.

E. Demonstration: With assistance from factory-authorized service representatives, demonstrate to Owner's maintenance and clerical personnel and building occupants how to operate the following systems and equipment:
   1. Lighting control devices specified in Section 260923 "Lighting Control Devices."
   2. Electronic metering and billing software specified in Section 262713 "Electricity Metering."

F. Training: With assistance from factory-authorized service representatives, train Owner's maintenance personnel on the following topics:
   1. How to implement Facility EPM Program.
   2. How to adjust, operate, and maintain equipment specified in Section 111136 "Vehicle Charging Equipment."
   3. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in study report specified in Section 260573.16 "Coordination Studies."
   4. Electrical power safety fundamentals refresher including arc-flash hazard safety features of electrical power distribution equipment in facility, interpreting arc-flash warning labels, selecting appropriate personal protective equipment, and understanding significance of findings documented in study report specified in Section 260573.19 "Arc-Flash Hazard Analysis."
   5. How to adjust, operate, and maintain systems specified in Section 260913 "Electrical Power Monitoring."
   6. How to adjust, operate, and maintain devices specified in Section 260923 "Lighting Control Devices."
   7. ow to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories specified in Section 262413 "Switchboards."
   8. How to adjust, operate, and maintain hardware and software specified in Section 262713 "Electricity Metering."
   9. How to adjust, operate, and maintain stage lighting equipment specified in Section 265561 "Theatrical Lighting."
   10. How to adjust, operate, and maintain luminaires and photoelectric controls specified in Section 265619 "LED Exterior Lighting."

END OF SECTION

SECTION 26 05 13 - MEDIUM-VOLTAGE CABLES AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 26 Section "Hangers and Supports for Electrical Systems.

1.02 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium- voltage (MV) electrical distribution systems.

B. Provide the following termination assemblies:
1. 200A & 600A are two standard amperages. Selection should be based on facility standard or the load you are designing for.
2. 600A bolted cable terminations at MV switchgear.
3. 600A separable elbows at main service MV transformers.
4. 600A separable Bolted T-splice in underground vault(s).
5. 600A 4-Way MV separable elbows in underground vault(s) and above-ground metal-enclosed cabinets.
6. Use these on elbows only
7. Test point fault indicators with remote monitoring.
8. Clamp-on fault indicators.
9. Use these at end of radial feeders via loop switch on transformers.
10. MOV separable elbows at main service MV transformers.
11. Refer to electrical single-line diagrams for additional requirements.

1.03 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

B. Cable splice: Where the joining of two or more cable ends is accomplished by using field installed non-separable connector assembly that joins another cable end.

C. Cable connector: Where a cable end is field joined to a factory-made separable connector assembly that can be attached and unattached to a mating termination fitting on a piece of equipment. 600A connectors are dead-break rated and require the system to be shutdown prior to disconnection. 200A elbows shall be load-break rated.

D. Cable termination: Where a cable end is field joined to a factory-made assembly with compression type lug bolted to a bus bar on the piece of equipment.

E. Termination assembly(ies): Refers to all components associated with cable splices, cable connectors and cable terminations.

F. Separable connector: A cable is terminated in a factory-made assembly unit that can be attached and unattached to another similar unit without damage to the connection or the cable ends.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.

C. Cable-pulling calculations indicating the maximum pulling tension of the cable will not be exceeded in PDF, MS Word, or MS Excel format. Provide calcs prior to cable installation.

D. Dynamometer readings recorded during cable pulling in PDF, MS Word or MS Excel format per submittal schedule.

1.05 INFORMATIONAL SUBMITTALS

A. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article. Defaulted to Installer. No Qual Data for Testing agency

B. Qualification Data: For Installer.

C. Material Certificates: For each cable and accessory type, signed by manufacturers.

D. Delete test reports below if not required.

E. Source quality-control test reports.

F. Retain paragraph below if Contractor is responsible for field quality-control testing.

G. Field quality-control test reports.

H. Coordination drawings including routing and elevations.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer of medium voltage electrical cable to perform the installation specified in this section. Cable splices, connectors and terminations shall be made by certified workman with a minimum of 5 years' experience in terminating the specific types of cable and cable accessories specified in this Section.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Each reel of cable furnished shall be newly manufactured, no more than 12 months old.

F. Codes and Standards: Conform to the following Standards:
   1. NFPA 70.
   2. Electrical components and/or systems shall be listed and labeled by a nationally recognized testing laboratory (NRTL) such as: UL, ETL, CSA, or FM; shall be labeled and/or listed as part of a UL-labeled assembly, or shall be evaluated by a third party acceptable to the authority having jurisdiction (AHJ) as suitable for the use intended. All labels shall be applied at the manufacturer's factory or facility prior to shipment.
   3. AEIC – Association of Edison Illuminating Companies.
   4. AEIC CG5-2005 – Underground Extruded Power Cable Pulling Guide.
   5. AEIC CS8-2007 – Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV.
   6. IEEE C2-latest – National Electrical Safety Code (NESC) Part 3: Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Lines.
   7. ASTM B496-04-2010 – Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.

8. ICEA – Insulated Cable Engineer's Association.
   a. ICEA S-93-639 / NEMA WC 74-2006 – 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. ICEA S-94-649-2004 – Standard for Concentric Neutral Cables Rated 5 Through 46 kV.
   c. ICEA S-96-659 / NEMA WC71-1999 – Standard for NonShielded Cables Rated 2001 5000 Volts for Use in the Distribution of Electric Energy.
   d. ICEA S-97-682-2007 – Standard for Utility Shielded Power Cables Rated 5 Through 46 kV.
9. IEEE
   a. IEEE 48™-latest – IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV Through 765 kV or Extruded Insulation Rated
   b. 2.5 kV Through 500 kV.
   c. IEEE 386™-latest – IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V.
   d. IEEE 400.1™-latest – IEEE Guide for Field Testing of Laminated Dielectric, Shielded Power Cable Systems Rated 5 kV and Above with High Direct-Current Voltage.
   e. IEEE 404™-latest – IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2,500V to 500,000 V.
   f. IEEE 525™-latest – IEEE Guide for the Design and Installation of Cable Systems in Substations.
   g. IEEE 576™-latest – Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.
   h. IEEE 835™-latest – IEEE Standard Power Cable Ampacity Tables.
10. NECA NEIS 600-2003 – Recommended Practice for Installing and Maintaining Medium- Voltage Cable.
11. NETA – InterNational Electrical Testing Association Inc.
12. NETA ATS-latest – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
13. UL
   a. UL 510-latest – UL Standard for Safety, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
   b. UL 1072-latest – UL Standard for Safety, Medium-Voltage Power Cables.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver medium voltage cable on factory reels conforming to NEMA Standard WC 26 - Wire and Cable Packaging. Reels with unsealed cable ends will be recorded and rejected by the Owner's representative.

B. Store cables on reels on elevated platforms in a clean, dry location.

C. On receipt, inspect cable protective covering for evidence of damage during shipment. Report immediately to carrier if evidence of damage is found.

D. Accomplish unloading without contacting cable surface or protective wrap. If unloading by crane, use cradle supporting reel flanges or a shaft through arbor hole. If using a forklift, lift the reel at 90 degrees to flanges. Use forms long enough to make complete lifting contact with both reel flanges.

E. If using inclined ramp for unloading, use ramp wide enough to contact both reel flanges completely. Accomplish stopping of reels at bottom by using the reel flanges and not the surface of the cable.

F. Do not drop reels from delivering vehicle to ground.

G. Store reels on hard surface to prevent flanges from sinking into the earth and allow the weight of the reel and cable to rest on the cable surface.

H. Do not store reels in an area where construction equipment, falling or flying objects or other materials will contact the cable.

I. Store cable where chemicals or petroleum products will not be spilled or sprayed on the cable.

J. Store cable away from open fires or sources of high heat.

K. When a reel of cable is rolled from one point to another, check for and remove objects on surface that could contact or damage the cable surface or protective wrap. Roll reel in direction to prevent loosening of the cable on the reel.

L. Store cable according to manufacturer's recommendations, as a minimum. In addition, store cable in location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provisions for ventilation to prevent condensation and for protection from weather. If air temperature at the cable storage location will be below 5 degrees C, move cable to a heated (10 degrees C minimum) location. If necessary, properly store cable off site at Contractor's expense.

M. Seal cut cable ends using properly sized heat shrink cap to prevent moisture ingress to the internal part of the cable

1.09 EXTRA MATERIALS

A. Provide three (3) snap-on, hot-stick operable capacitive test point caps.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Revise paragraph below to suit Project. See Editing Instruction No. 1 in the Evaluations.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.02 CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cables:
      a. General Cable Technologies Corporation.
      b. Okonite Company (The).
      c. Pirelli Cables & Systems NA.
      d. Prysmian.
      e. Rome Cable Corporation.
      f. Southwire Company.
   2. Cable Splicing and Terminating Products and Accessories:
      a. Raychem: Tyco Electronics.
      b. RTE Components; Cooper Power Systems, Inc.
      c. Elastimold/ABB.
      d. 3M; Electrical Products Division.
   3. Tapes
      a. 3M Scotch® 24 – Electrical Shielding Tape.
      b. 3M Scotch® 27 – Glass Cloth Electrical Tape.
      c. 3M Scotch® 33 – Electrical Tape.
      d. 3M Scotch® 69 – Glass Cloth Electrical Tape.
      e. 3M Scotch® 77 – Fire Retardant Electric Arc Proofing Tape.
      f. 3M Scotch® 130C – Linerless Rubber Splicing Tape.
      g. 3M Scotchfil™ - Electrical Insulation Putty.
      h. Insulating Materials Inc. (IMI) 202 – Irrathene Film, Class 105C Tape.
      i. Plymouth® Bishop® 53 Plyarc® – Arc and Fire Proofing Tape.
   4. Conductor and Cable Stripping Tools
      a. Acceptable Manufacturers

1) Greenlee.
2) Hi-Line Company
3) Ideal
4) Ripley Company (UtilityTool), BP A, BP 1A, BP 2A, Icon, PIT 1T, TSW 4550, WS 6, WS 7, WS 7A, WS 8, WS 8A, WS 15, WS 64-U, WS 5A, or WS 66
5) Speed Systems, Inc., 1542-2CL and 1700 Series.

2.03 MV CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.

C. Conductor: Copper or Aluminum.

D. Conductor Stranding: Concentric lay, Class B.

E. Conductor Insulation: Ethylene-propylene rubber. Conductor Insulation: Crosslinked polyethylene.
1. Voltage Rating: 5 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding:
1. Two layers of 5-mil uncoated Copper tape, with minimum 12.5% overlap, helically applied over semiconducting insulation shield. The copper tape shall meet all of the requirements of Part 4 of ICEA.
2. Concentric neutral, solid copper wires helically applied over semiconducting insulation shield.

G. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.
1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

H. Cable Armor: Corrugated aluminum tube applied over cable.

I. Cable Jacket: Black, sunlight-resistant PVC. Use cable jacket meeting the electrical, physical and sunlight resistant requirements of ICEA S 93 639 / NEMA WC74 and of UL Standard 1072. The average thickness of the jacket shall be as specified in Part 4 of ICEA. Provide minimum thickness at any point of not less than 80 percent of that specified. CSA listed to C68.3.

2.04 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
   1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
   2. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.05 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
   1. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
   2. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy- resin casting material.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations. Terminations without sheds (skirts) are only allowed on indoor applications.
   1. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.06 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

E. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

F. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.07 SEPARABLE INSULATED MOV SURGE ARRESTERS

A. Description: Modular system, complying with IEEE 386, with single-pole, plug-in, dead-front surge arrester designed for system voltage and for sealing against moisture.

B. The pre-molded parts shall be suitable for indoor, outdoor, and submersible applications.

C. The arrester shall be designed with a 60 Hz sparkover of 1.5 times its duty cycle rating. The operation of the MOV arrester shall have the line voltage shared by both resistance graded gap structure and metal oxide varistors (MOV). When overvoltages occur, the gaps sparkover, leaving only the metal oxide varistors in the circuit. This shall result in lower discharge voltages than are possible with gapless metal oxide arresters.

D. Performance Test Characteristics: The MOV surge arrester shall withstand the following design tests as described by IEEE Standard C62.11
1. Duty Cycle: 22 current surges of 5 kA crest, 8/20 µs waveshape.
2. High-Current, Short-Duration Discharge: 2 current surges of 40 kA crest, 4/10 µs waveshape.
3. Low-Current, Long-Duration Discharge: 20 current surges of 75 A crest, 2000 µs rectangular wave duration.

2.08 ARC-PROOFING MATERIALS

A. General: Provide fire taping of all medium voltage cables and termination assemblies inside vaults, including existing cables if present.

B. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

C. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

D. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.09 FAULT INDICATORS

A. Provide automatic reset, in-rush restraint type fault indicators at all splices and at all terminations. Provide all mounting kits and adapters as required. Manufacturer to recommend correct trip ratings at each location to be used. Manual reset types are prohibited. Provide a display that a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Mounting: Arranged to clamp to cable sheath on cable terminations or test points on elbow connectors.

C. Provide Cooper power systems, or equal, S.T.A.R. (capacitive test point) fault indicator with three-phase remote display on all separable connectors.

D. Provide corrosion resistant, clamp-on current type reset units on terminations without capacitive test points. Cooper Power Systems, or equal, CRR3PD fault indicator with three-phase remote display on all solid terminations.

E. Provide one test point testing tool suitable for each type of indicator.

2.10 SOURCE QUALITY CONTROL

A. Edit paragraph below for cable type specified. First option refers to shielded cable, second to concentric neutral cable designs.

B. Test and inspect cables according to ICEA S-94-649 before shipping.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that each conduit is ready to receive work. Use properly sized mandrel to determine if installed conduit is suitable for use.

B. Verify field measurements are as shown on Drawings.

C. Record field-measured lengths of cable and forward to the Contractor.

D. Beginning of installation means Contractor accepts existing conditions.

3.02 PREPARATION

A. Thoroughly swab conduits and pipes to remove foreign material before pulling cables.

3.03 INSTALLATION

A. Permanent splices are not allowed. All splices shall be made with separable connectors and shall occur only in vaults and pullboxes.

B. All equipment terminations shall be made via two-hole bolted lugs or separable elbow connectors, as indicated.

C. Install cable and terminations in accordance with IEEE Standard 576.

D. Install cable and terminations in accordance with manufacturer's instructions and installation guidelines.

E. Avoid abrasion and other damage to cables during installation. Install cable as indicated on plan drawings and cable schedules.

F. Pulling Conductors:
1. Do not exceed manufacturer's recommended bending radius, maximum pulling tensions and sidewall pressure values.
2. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
4. Pull cables using suitable cable-pulling equipment. Do not exceed cable-pulling tensions or minimum-bending radius recommended by manufacturer.
5. Include approval of cable pull setup by Contractor and Owner prior to each pull.
6. Where pulling equipment is attached to columns, structure, or strut framework, ensure maximum stress limitations of support and structure systems are not exceeded.
7. During the pulling operation, use dynamometer to record the pulling tension. Give notice to Owner before cable is pulled so his representative can observe pull. Record dynamometer readings.
8. Include witnessing of cable pulls by cable manufacturer and certification by manufacturer that cable was not damaged during installation. Include witnessing of dynamometer readings and certification that the manufacturer's allowable pulling tension for each pull was not exceeded.
9. Install cable using mechanical means with cable pulling equipment, pulleys, sheaves, wheel, and rollers. Use of hydraulic or electric pulling equipment with smooth, variable speed control is required. Do not manually pull in cables.
10. Use correctly sized cable pulley (sheave) for each cable-pull. Size sheave diameter per cable calculations. Use sheave wide enough for cables to properly ride over the sheave. Do not use narrow sheaves. Set up sheaves for direct reading from dynamometer.
11. Use listed pulling compounds compatible with the cable's outer jacket, the raceway involved, and acceptable to the cable manufacturer. If compatible, use Polywater® Type J or F lubricant.

12. Do not exceed pulling tension of 0.008 pounds per circular mil of conductor cross sectional area.
13. Pull cable from end resulting in least amount of tension applied to cable. Pull cables down-grade with the feed-in point at the manhole or building with the highest elevation. Keep pulling tension to a minimum by liberal application of lubricant, hand turning of reel and slack feeding of cable into duct entrance. Employ not less than one person at each reel and one at each manhole during pulling operation. Use 6 personnel minimum when each phase is on a separate reel.
14. Remove all lashings used for temporary bunching of individual cables before they enter the raceways.
15. Install cable in manholes along those walls providing the longest route and most spare cable lengths. Loop cables around the entire inside diameter of manholes where possible. Arrange cable to avoid interferences with duct entrances into manhole to allow future cable installation without relocation of cables.
16. Where required, use pulling eyes and bolts with long barrel ferrules that compress on to the exposed conductors. Follow cable manufacturer's instructions for application of pulling eyes.
17. Do not pull cable into conduit embedded in concrete until after concrete is poured and has set up.
18. Where cable is pulled under tension over sheaves, conduit bends or other curved surfaces, select radium that will not result in excessive sidewall pressure and include sheaves, conduit bends or other curved surfaces in above calculations.

G. Splices, Taps and Terminations
1. Approved splices and taps are indicated on Drawings. Obtain preapproval from the Engineer or Owner in writing for any additional required splices and taps.
2. Provide terminals and connectors acceptable for the type of conductor used.
3. Follow the manufacturer's installation instructions for all approved splices, taps and terminations. For DIN plug-in connections, only factory trained and certified installers are to be used.
4. Ground/earth cable shield at each splices, taps and terminations.
5. Use tools specified in this Section, for the required task, instead of a standard utility knife, when cutting the outer jacket, tape-shields, semi-conductor insulation or stripping insulation from medium-voltage cables.
6. Support cable splices and taps on each side of the splice or tap. Locate splices or taps to prevent cyclic bending in the spliced sheath. Splices or taps shall not rely on the cable for support.
7. Provide temporary seal over exposed conductors using tape and heat shrink sleeving unless splicing and taps are to be completed immediately.
8. For grounding cable shield at each termination and splice, use one- or two-hole appropriately sized compression connectors on cable shields and join connectors using properly sized corrosion-resistant bolts, lock-washers and nuts. Install washers on the lug side of the connection. Torque bolts to recommended values. Split-bolt type connectors are not approved.

9. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.
10. Install separable insulated-connector components as follows:
    a. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
    b. Portable Feed-Through Accessory: Three.
    c. Standoff Insulator: Three.

H. Other Installation Requirements
1. Locate approved splices and taps in manholes to enable periodic thermal imaging of the splice or tap to be carried out by Owner.
2. Cable types to be used:
    a. Single Conductor Medium-Voltage Cable - Shielded: Use for above and underground applications (except for Jumper Cable applications – see Jumper Cable below) and install in conduit or other raceways. Use in cable trays in dedicated electrical vaults or rooms only.
    b. Single Conductor Medium-Voltage Cable - Unshielded (Jumper): Use only between equipment in the same vicinity, such as between primary switch and transformer where adequate through-air clearance can be achieved between conductors. In general, do not use for installation in metallic raceways.
3. Support cables in manholes and similar locations with cable racks and secure to rack insulators with self-locking nylon cable ties. Place each cable on a separate insulator.
4. For single-conductor mounting, install all phases from the same circuit on the same rack. Do not install cables of more than one circuit on the same insulator.
5. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
6. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
7. [Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.]
8. Install warning tape 12 inches (305 mm) above cables per details in the construction drawings.
9. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
10. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."
11. Install fault indicators on each phase where indicated.
12. Avoiding Cable Strain: Cable shall be trained to final location and secured with temporary ties prior to any cutting. Terminations installed on the cable shall be oriented to permit completion of the termination without twisting or stressing the cable insulation.

13. Bending and Training Cable: The bend radius of any cable shall not be less than fifteen times the outside diameter of the cable jacket. Cable shall not be twisted.
14. Contractor shall be responsible for the correct phasing out of the conductors of each circuit at terminations and/or splices.

I. [Install cable splices at pull points and elsewhere as indicated; use standard kits.]

J. [Arc Proofing: After all tests have been performed and accepted, arc-proof medium voltage cables and termination assemblies within the manhole and at locations not protected by conduit or termination materials except where indicated. Do not fire tape termination assemblies in medium voltage switchgear or transformers. Fire tape each individual phase conductor. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Fireproof cables installed in manholes with one layer of one-half-lapped 3M Scotch® 77 or Plymouth-Bishop 53 tape. Apply vinyl side to outside of wrap. Wrap 3M Scotch 27 or
5. 69 tape over fireproofing tape to hold the half-lapped tape in place and prevent unraveling.
6. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass- cloth tape 2 inches (50 mm) o.c.
7. Fireproof all three-phase cables together ending a minimum of 6 feet (1.83 m) from the splice or connectors, and then individually wrap each phase conductor up to the splice or connector. This works best if the individual wraps are applied first, and then the triplex-cables are wrapped afterward to overlap the tape and adequately protect all cable surfaces.
8. Completely cover each individual and triplex cable with fireproofing tape and hand-taped splices from duct entrance to duct exit.
9. Extend half-lapped wraps a minimum of 1-inch into all ducts.
10. Extend the fireproofing tape a minimum of 1-inch onto all splice and T-connector bodies.]

K. Termination requirements:
1. Torque values specified by the termination manufacturer must be strictly adhered to.
2. Contractor shall follow the termination manufacturers specified procedures, strictly, in detail.

L. Site and Work Conditions: The site of the work and working conditions and procedures shall comply with the following:
1. Clean dry work site a clean dry site shall be provided for constructing all terminations. Termination work shall be done only in sunny dry weather, unless a heated and lighted enclosure for the work is provided by the Contractor.
2. Clean drop cloths shall be provided for laying of parts and tools.

3. Hand cleaning supplies packaged cleaning tissues impregnated with an evaporating cleaning compound and clean dry cotton cloths shall be provided for the termination workmen to clean and dry their hands.
4. Adequate lighting natural or artificial lighting provided by the Contractor, shall be used to provide not less than 200 footcandles on the work to be assembled.
5. Manufacturer's instructions work will be permitted at such time as the termination manufacturers installation and assembly instructions are at work site and easily available to the termination workmen.
6. Required tool set all tools required for assembly shall be at the work site prior to beginning termination. The set shall include:
    a. Cable shears and hacksaw (or rotating blade cable cutter). Roughing cut may be made with shears. Final cable cut shall be made with hacksaw or rotating blade cable cutter.
    b. Crimping tool with proper dies for conductors terminated, including grounding cable and ground leads from ground adapters.
    c. Torque wrench (and spanner wrench for 600 amp).
    d. Rotary blade insulation cutter and sharp knife.
    e. Sandpaper and insulation file.

3.04 CABLE GROUNDING:

A. Ground shields of all shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware in accordance with manufacturer’s written instructions. Use cable shield adaptor kits, unless noted otherwise.

B. Connect the primary cable grounding conductors to the ground lug at the transformers and in turn to the ground rod.

C. The shields of all primary cable terminations shall be bonded to the local ground in each piece of equipment.

D. Bare #4/0 AWG, copper 600 volt, equipment ground conductor shall be provided in all medium voltage cable runs.

E. Ground all cable shields to new #4/0 AWG bare copper ring around interior of each vault. Bond ring to new ground rods and to new #4/0 bare copper conductors in medium voltage conduit runs.

F. For grounding cable shield at each termination and splice, use one- or two-hole appropriately sized compression connectors on cable shields and join connectors using properly sized corrosion-resistant bolts, lock-washers and nuts. Install washers on the lug side of the connection. Torque bolts to recommended values. Split-bolt type connectors are not approved.

3.05 INSTALLATION OF CABLE ACCESSORIES

A. Tape for first course on metal objects in contact with cable, such as racks, shall be 10 mil thick, corrosion protective, moisture resistant PVC pipe wrapping tape.

B. Fault Indicators: Mount remote 3-phase display unit in location noted:
   1. Vaults: Point 3-phase display face toward ladder.
   2. Switchgear: Flush mounted through housing with 3-phase display on the outside. Provide label to indicate with circuit is represented.

3.06 IDENTIFICATION

A. Identify cables according to Division 26 Section "Identification for Electrical Systems."

B. Cables shall be identified in two locations:
   1. Identify each cable bundle (related A, B and C phase cables) as to manufacturer's product number (MV-105), year installed, voltage (15 kV), conductor size, and Owner's circuit numbering scheme.
   2. Identify each phase cable as to Phase, conductor size, and Owner's circuit numbering scheme.

C. Identification shall be carried in plastic embossed letter holder permanently secured with black nylon ty-wraps where the cable emerges into each and all manholes or switchgear. Identification shall be applied over the fire tapping where present.

D. The cables shall be identified with a 2" wide band of Scotch 35 colored insulation tape adjacent to all splices and terminations. The colors shall correspond to the following code.
   1. Phase A Two red bands.
   2. Phase B Two yellow bands
   3. Phase C Two blue bands

E. Equipment grounding conductor Green

F. Provide above mentioned identification on all new cables and all existing cables in each underground vault.

3.07 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

A. Remove and replace malfunctioning items and retest as specified above.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Copper building wire.
2. Photovoltaic cable, Type PV.
3. Tray cable, Type TC.
4. Connectors and splices.

B. Related Requirements:
1. Section 26 0513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.
2. Section 27 1313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
3. Section 27 1513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.02 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. General Cable
2. Rome
3. Southwire
4. Or equal.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:
   1. Type NM: Comply with UL 83 and UL 719.
   2. Type RHH and Type RHW-2: Comply with UL 44.
   3. Type USE-2 and Type SE: Comply with UL 854.
   4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
   5. Type THHN and Type THWN-2: Comply with UL 83.
   6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
   7. Type UF: Comply with UL 83 and UL 493.
   8. Type XHHW-2: Comply with UL 44.

F. Shield:
   1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.02 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Available Manufacturers: Ideal Industries, 3M, “ScotchLok”, “T&B”, Burndy, or equa

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper.
   2. Type: Two hole with standard barrels.
   3. Termination: Compression.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:
   1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
   2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:
   1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
   2. Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

E. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway Type USE, single conductor in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

I. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.

3.03 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.04 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material.
1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch (150 mm) of slack.

3.05 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 8413 "Penetration Firestopping."

3.08 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding critical equipment.
   3. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench
         3) Thermographic survey
   4. Inspect compression-applied connectors for correct cable match and indentation.
   5. Inspect for correct identification.
   6. Inspect cable jacket and condition.
   7. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
   8. Continuity test on each conductor and cable.
   9. Uniform resistance of parallel conductors.
   10. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

11. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:
1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - PART 1 - GENERAL

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.
   3. Foundation steel electrodes.

C. Related Requirements:
   1. Section 26 0010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
   2. Section 26 0011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.01 ACTION SUBMITTALS

A. A.Product Data: For each type of product indicated.

1.02 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.

B. Field quality-control reports.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   1. Include the following:
      a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
         1) Test wells.
         2) Ground rods.
         3) Ground rings.
         4) Grounding arrangements and connections for separately derived systems.
      b. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on NETA MTS.
         1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
         2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the followings:
   1. Eritech / Erico
   2. Blackburn / Thomas & Betts
   3. Galvan Industries

2.03 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B3.
   2. Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1- 5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inch (6.3 by 100 mm) in cross section, with 9/32 inch (7.14 mm) holes spaced 1-1/8 inch (28 mm) apart. Stand-off insulators for mounting must comply with UL 891 for use in switchboards, 600 V and must be Lexan or PVC, impulse tested at 5000 V.

2.04 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Mechanical-Type Bus-Bar Connectors: Cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Compression-Type Bus-Bar Connectors: Copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper, cast-bronze clamp. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:
1. Mechanical type, two pieces with zinc-plated bolts.
2. Material: Die-cast zinc alloy.
3. Listed for direct burial.
4. U-bolt type with malleable-iron clamp and copper ground connector.

2.05 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 ft. (19 mm by 3 m).

B. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
1. Bury at least 30 inch (750 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inch (50 mm) minimum from wall, 6 inch (150 mm) above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors must be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode must be connected to the equipment grounding conductor and to the frame of the generator.

3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch (50 mm) above to 6 inch (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inch (150 mm) from the foundation.

3.05 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

C. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.06 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inch (50 mm) below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. Use exothermic welds for all below-grade connections.
   3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch (300 mm) deep, with cover.
   1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft. (18 m) apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inch (600 mm) from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 ft. (6 m) of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 ft. (6 m) long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft. (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.07 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   4. Substations and Pad-Mounted Equipment: 5 ohms.
   5. Manhole Grounds: 10 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Support, anchorage, and attachment components.
2. Fabricated metal equipment support assemblies.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
2. Slotted support systems, hardware, and accessories.
3. Clamps.
4. Hangers.
5. Sockets.
6. Eye nuts.
7. Fasteners.
8. Anchors.
9. Saddles.
10. Brackets.
11. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For hangers and supports for electrical systems.

1.03 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
1. Available Manufacturers: ABB, Electrification Business, Gripple Inc., Robroy Industries
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
1. Available Manufacturers: ABB, Electrification Business or equal.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Material: 6063-T5 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.

5. Channel Width: Selected for applicable load criteria.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325 (Grade A325M).
6. Toggle Bolts: All steel springhead type.
7. Hanger Rods: Threaded steel.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 5000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA NEIS 101

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch (6 mm) in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch (38 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.02 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.

5. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69] [Spring-tension clamps].
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

A. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inch (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000 psi (20.7 MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup:
1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
2. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

3. Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
1. Section 07 8413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
3. Section 27 0528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.03 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electric Metallic Tube.

C. ENT: Electrical Nonmetallic Tube.

D. FMC: Flexible Metal Conduit.

E. GRC: Galvanized rigid steel conduit.

F. HDPE: High Density Polyethylene.

G. IMC: Intermediate metal conduit.

H. LFMC: Liquid-tight Flexible Metal Conduit.

I. LFNC: Liquid-tight Flexible Nonmetallic Conduit.

J. RNC: Rigid Nonmetallic Conduit.

K. RTRC: Reinforced Thermosetting Resin Conduit (Fiberglass).

1.04 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. GRC: Comply with ANSI C80.1 and UL 6.

3. ARC: Comply with ANSI C80.5 and UL 6A.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit or IMC.
6. Comply with NEMA RN 1.
7. Coating Thickness: 0.040 inch (1 mm), minimum.
8. EMT: Comply with ANSI C80.3 and UL 797.
9. FMC: Comply with UL 1; zinc-coated steel or aluminum.
10. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
6. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:
3. Comply with NEMA TC 14.
4. Comply with UL 2515 for aboveground raceways.
5. Comply with UL 2420 for belowground raceways.
6. ENT: Comply with NEMA TC 13 and UL 1653.
7. RNC: Type EPC-40-PVC or Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
8. LFNC: Comply with UL 1660.
9. Rigid HDPE: Comply with UL 651A.
10. Continuous HDPE: Comply with UL 651A.
11. Coilable HDPE: Preassembled with conductors or cables and complying with ASTM D3485.
12. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
   a. Fittings for LFNC: Comply with UL 514B.
3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type or Screw-cover type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.04 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.05 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Tele-Power Poles:
1. Material: Galvanized steel or Aluminum with finish and color selected by the architect.
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.06 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:
1. Type: Adjustable.
2. Shape: Rectangular unless otherwise indicated.
3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes:
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) unless otherwise indicated.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:
1. NEMA 250 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.07 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
2. First option in "Configuration" Subparagraph below facilitates bottom conduit entry. Second option may be provided by a separate slab placed in the excavation under

an open-bottom enclosure; third option is obtained by molding or fabricating the bottom integrally with the body of unit.

3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.

1. Standard: Comply with SCTE 77.
2. Color of Frame and Cover: by Architect.
3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

2.08 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: RNC, Type EPC-40-PVC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried unless otherwise indicated.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Conduit exposed to cooling tower water or chemicals: Type EPC-80-PVC.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Physical Damage: IMC. Including, but not limited to the following locations:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums.
   e. <Insert designations of applicable spaces or locations>.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: IMC.
6. Metal Floor Boxes: Cast iron for on-grade installations, stamped steal or cast metal for above-grade installations.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel or cast-metal fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.02 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of four 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to IMC before rising above floor.

M. Stub-Ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:
1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Conduit extending from interior to exterior of building.
   4. Conduit extending into pressurized duct and equipment.
   5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C)
      b. temperature change.
      c. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C)
      d. temperature change.
      e. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
      f. Attics: 135 deg F (75 deg C) temperature change.
      g. <Insert location and corresponding temperature change>.
   3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
   4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line. Contractor to confirm frost line depth with the local AHJ.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.06 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.07 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Type EPEC raceways and fittings.
2. Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type IMC raceways.
5. Type PVC raceways and fittings.
6. Type RTRC-BG raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Threaded metal joint compound.
9. Solvent cements.
10. Duct accessories.
11. Handholes and boxes for exterior underground wiring.
12. Manholes for exterior underground wiring.
13. Utility structure accessories.
14. Duct sealing.

B. Related Requirements:
1. Section 26 0010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 0011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 26 0519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

1.02 ALLOWANCES

A. See Section 01 2100 "Allowances" for description of allowances affecting items specified in this Section.

1.03 UNIT PRICES

A. See Section 01 2200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.04 ALTERNATES

A. See Section 01 2300 "Alternates" for description of alternates affecting items specified in this Section.

1.05 DEFINITIONS

A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.

B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.

C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.

D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.06 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

B. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) as videoconference or at Project site.
   1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect, Construction Manager, and Owner's Commissioning Authority of scheduled meeting dates.

1.07 ACTION SUBMITTALS

A. Product Data:
   1. Duct-bank materials, including spacers and miscellaneous components.
   2. Ducts, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Accessories for manholes, handholes, boxes, and other utility structures.
   4. Underground-line warning tape.
   5. Warning planks.

B. Shop Drawings:
   1. Precast or Factory-Fabricated Concrete Structures:
      a. Include plans, elevations, sections, and details, including attachments to other Work.
      b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.

c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder step details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

C. Field Quality-Control Submittals:
1. Field quality-control reports.

D. Sustainable Design Submittals:

1.08 INFORMATIONAL SUBMITTALS

A. Certificates:
1. For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.

B. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
1. For Type ERMC-S-PVC.

C. Source Quality-Control Submittals:
a. Source quality-control reports.

1.09 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts necessary for repairing or adding more cables to manholes or handholes that are packaged with protective covering for storage and identified with labels describing contents.
1. Cable-Support Stanchions, Arms, Insulators, and Associated Fasteners: Five percent of quantity of each item installed.

1.10 REGULATORY AGENCY APPROVALS

A. Shop Drawing submittals for electric utility duct banks and structures must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by electric utility prior to submitting for action by Architect. Submit for action by Architect prior to submitting for approval by electric utility.

B. Submit Shop Drawings for electric utility duct banks and structures for action by Architect prior to submitting for approval by electric utility.

PART 2 - PRODUCTS

2.01 TYPE EPEC RACEWAYS AND FITTINGS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651A and UL CCN EAZX.

B. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40):
1. Dimensional Specifications: Schedule 40.
2. Options:
a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

C. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80):
1. Dimensional Specifications: Schedule 80.
2. Options:
a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

D. Type A Electrical HDPE Underground Conduit (EPEC-A):
1. Dimensional Specifications: Type A.
2. Options:
a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

E. Type B Electrical HDPE Underground Conduit (EPEC-B):
1. Dimensional Specifications: Type B.
2. Options:
a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.02 TYPE ERMC-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6A and UL CCN DYWV.

B. Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples:
   1. Material: Stainless steel.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      b. Colors: As indicated on Drawings.

2.03 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
   1. Exterior Coating: Zinc.
   2. Options:
      a. Interior Coating: Zinc with organic top coating.
      b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      c. Colors: As indicated on Drawings.

C. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
   1. Additional Characteristics:
   2. Fittings for PVC-Coated Conduit:
      a. Minimum coating thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
      b. Conduit bodies must be Form 8 with effective seal and positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 inch Hg (vacuum) for 72 hours must be available. Conduit bodies must be supplied with plastic-encapsulated stainless steel cover screws.
      c. Form 2 inch (51 mm) long or one pipe diameter long, whichever is less, PVC sleeve at openings of female fittings, except unions. Inside sleeve diameter must be matched to outside diameter of metal conduit.
      d. PVC coating on outside of conduit couplings must be protected from tool damage during installation.
      e. Female threads on fittings and couplings must be protected by urethane coating.
      f. Fittings must be from same manufacturer as conduit.
      g. Beam clamps and U bolts must be formed and sized to fit outside diameter of coated conduit. Plastic-encapsulated nuts must cover exposed portions of threads.

3. Options:
   a. Exterior Coating: PVC complying with NEMA RN 1 and marked ETL Verified PVC-001.
   b. Interior Coating: Zinc with organic top coating.
   c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
   d. Colors: As indicated on Drawings.
   e. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
   f. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.04 TYPE IMC RACEWAYS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):
   1. Options:
      a. Exterior Coating: Zinc.
      b. Interior Coating: Zinc with organic top coating.
      c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      d. Colors: As indicated on Drawings.

2.05 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
   1. Dimensional Specifications: Schedule 40.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      b. Markings: For use with maximum 90 deg C wire. For directional boring applications.

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
   1. Dimensional Specifications: Schedule 80.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      b. Markings: For use with maximum 90 deg C wire. For directional boring applications.

D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:
   1. Dimensional Specifications: Type A.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:
   1. Dimensional Specifications: Type EB.
   2. Options:
      a. Minimum Trade Size: Metric designator 53 (trade size 2).

2.06 TYPE RTRC-BG RACEWAYS AND FITTINGS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL 2420 and UL CCN DZKT, for Type BG.

B. Low-Halogen, Belowground Reinforced Thermosetting Resin Conduit (RTRC-BG) and Fittings:
   1. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.07 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:
   1. General Characteristics: UL 514B and UL CCN DWTT.
   2. Options:
      a. Material: Steel.
      b. Coupling Method: Raintight compression coupling with distinctive color gland nut.
      c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
      d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.08 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

2.09 SOLVENT CEMENTS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
3. Sustainability Characteristics:

B. Solvent Cements for Type PVC Raceways and Fittings:

2.10 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: In accordance with Section 260553 "Identification for Electrical Systems."

C. Concrete Warning Planks: Nominal 12 by 24 by 3 inch (300 by 600 by 75 mm) in size, manufactured from 6000 psi (41 MPa) concrete.
1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2 inch (50 mm) high, 3/8 inch (10 mm) deep letters.

2.11 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

B. Source Quality Control:
1. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
2. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
a. Tests of materials must be performed by independent testing agency.
b. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.

C. Precast Concrete Handholes and Boxes:
1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.
2. Configuration: Units must be designed for flush burial and have integral closed
3. bottom unless otherwise indicated.
4. Frame and Cover:
   a. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   b. Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   c. Weatherproof steel frame, with concealed-hinge steel access door assembly; tamper-resistant, captive, cover-securing bolts; hold-open ratchet assembly; and recessed cover handle.
   d. Weatherproof aluminum frame, with concealed-hinge aluminum access door assembly; tamper-resistant, captive, cover-securing bolts; hold-open ratchet assembly; and recessed cover handle.
   e. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
   f. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension must provide increased depth of [12 inch (300 mm)].
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
7. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch (300 mm) vertically and horizontally to accommodate alignment variations.
   a. [Splayed] [Center window] location.
   b. Knockout panels must be located no less than 6 inch (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   d. Knockout panels must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   e. Knockout panels must be 1-1/2 to 2 inch (38 to 50 mm) thick.
8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size: Match fittings to duct to be terminated.
   b. Fittings must align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
   c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.

9. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:
   1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.
   2. Configuration: Units must be designed for flush burial and have [open] [closed] [integral closed] bottom unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.
      a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
      b. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
   4. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.
   5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
   7. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
   8. Options:
      a. Color: Gray.

E. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover:
   1. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
   2. Configuration: Units must be designed for flush burial and have integral closed
   3. bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
      a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
      b. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
   5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
   7. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
   8. Options:
      a. Color: Gray.

F. Fiberglass Handholes and Boxes:
1. Description: Molded of fiberglass-reinforced polyester resin, with covers made of [polymer concrete] [reinforced concrete] [cast iron] [hot-dip galvanized-steel diamond plate] [reinforced fiberglass].
2. Configuration: Units must be designed for flush burial and have integral closed
3. bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
   b. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
7. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
8. Options:
   a. Color: Gray.

G. High-Density Polyethylene (HDPE) Boxes:
1. Description: Injection molded of HDPE or copolymer-polypropylene. Cover must be made of hot-dip galvanized-steel diamond plate.
2. Configuration: Units must be designed for flush burial and have integral closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
   b. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
4. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
5. Duct Entrance Provisions: Duct-terminating fittings must be installed perpendicular to box wall and mate with entering duct for secure, fixed installation in enclosure wall without putting stress on box wall or fitting.
6. Options:
   a. Color: Gray.

2.12 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
   a. ASTM C858 for design and manufacturing processes.
   b. SCTE 77.

B. Precast Concrete Manholes:
   1. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
   2. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch (300 mm) vertically and horizontally to accommodate alignment variations.
      a. Center window location.
      b. Knockout panels must be located no less than 6 inch (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
      c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
      d. Knockout panel must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
      e. Knockout panels must be 1-1/2 to 2 inch (38 to 50 mm) thick.
   3. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
      a. Type and size: Match fittings to duct to be terminated.
      b. Fittings must align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
      c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.
   4. Ground Rod Sleeve: Provide 3 inch (75 mm) PVC sleeve in manhole floors 2 inch (50 mm) from wall adjacent to, but not underneath, duct entering structure.
   5. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
   6. Source Quality Control: Test and inspect in accordance with ASTM C1037.

C. Cast-In-Place Concrete Manholes:
   1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.
   2. Additional Criteria: Comply with Section 033000 "Cast-in-Place Concrete."

2.13 UTILITY STRUCTURE ACCESSORIES

A. Description: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application, and complying with the local utility company requirements.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   1. Frame and Cover: Weatherproof, [gray cast iron complying with ASTM A48/A48M, Class 30B] [cast aluminum] with milled cover-to-frame bearing surfaces; diameter, 26 inch (660 mm).

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in; selected to suit system.
   a. Legend:
      1) "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
      2) "ELECTRIC-HV" for duct systems with medium-voltage cables.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
   a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft (60 L) where packaged mix complying with ASTM C387/C387M, Type M, may be used.
   b. Seal joints watertight using preformed plastic or rubber complying with ASTM C990. Install sealing material in accordance with sealant manufacturers' published instructions.

C. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2 inch (50 mm) diameter eye, and 1-by-4 inch (25-by-100 mm) bolt.
1. Working Load Embedded in 6 inch (150 mm), 4000 psi (27.6 MPa) Concrete: 13,000 lbf (58 kN) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4 inch (31 mm) diameter eye, rated [2500 lbf (11 kN)] minimum tension.

F. Pulling-in and Lifting Irons in Concrete Floors: 7/8 inch (22 mm) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; fastened to reinforcing rod; and with exposed triangular opening.
1. Ultimate Yield Strength: 40,000 lbf (180 kN) shear and 60,000 lbf (270 kN) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2 inch (13 mm) ID by 2-3/4 inch (69 mm) deep, flared to 1-1/4 inch (31 mm) minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

H. Ground Rod Sleeve: 3 inch (75 mm) PVC sleeve in manhole floors 2 inch (50 mm) from wall adjacent to, but not underneath, ducts routed from facility.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless steel expander clip with 1/2 inch (13 mm) bolt, 5300 lbf (24 kN) rated pullout strength, and minimum 6800 lbf (30 kN) rated shear strength.

J. Steel Cable Rack Assembly: Hot-rolled galvanized, except insulators.
1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form continuous unit; 1-1/2 inch (38 mm) in width by nominal 24 inch

(600 mm) long; punched with 14 hook holes on 1-1/2 inch (38 mm) centers for cable-arm attachment.

2. Arms: 1-1/2 inch (38 mm) wide, lengths ranging from 3 inch (75 mm) with 450 lb (204 kg) minimum capacity to 18 inch (450 mm) with 250 lb (114 kg) minimum capacity. Arms must have slots along full length for cable ties and be arranged for secure mounting in horizontal position at vertical locations on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Nonmetallic Cable Rack Assembly: Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inch (900 mm) high by 4 inch (100 mm) wide, with provisions to connect to other sections to form continuous unit, with minimum of nine holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at locations on cable stanchions, and capable of being locked in position. Arms must be available in lengths ranging from 3 inch (75 mm) with 450 lb (204 kg) minimum capacity to 20 inch (500 mm) with 250 lb (114 kg) minimum capacity. Top of arm must be nominally 4 inch (100 mm) wide, and arm must have slots along full length for cable ties.

L. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces must be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

M. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Length must be not less than distance from deepest manhole floor to grade plus 36 inch (900 mm). Two ladder(s) are required.

N. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater Light duty, designed for lifts less than 60 lbf (270 N). Two ladders(s) are required.

2.14 DUCT SEALING

A. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Compound must be capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.

B. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 311000 "Site Clearing."

3.02 SELECTION OF UNDERGROUND DUCTS

A. Duct for Electrical Cables More Than 600 V: PVC-40, concrete encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less:PVC-40, concrete encased unless otherwise indicated.

C. Duct for Electrical Branch Circuits: PVC-40, direct buried unless otherwise indicated.

D. Bored Underground Duct: EPEC-40 unless otherwise indicated.

E. Underground Ducts Crossing Paved Paths, Walkways, and Driveways: PVC-40 direct buried.

F. Underground Ducts Crossing Roadways and Railroads: PVC-40, encased in reinforced concrete.

G. Stub-ups: Concrete encased, PVC-40.

3.03 SELECTION OF UNDERGROUND ENCLOSURES

A. Handholes and Boxes:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-10 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.

3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested in accordance with SCTE 77 with 3000 lbf (13 345 N) vertical loading.
5. Cover design load must not exceed load rating of handhole or box.

B. Manholes: Precast or cast-in-place concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating in accordance with AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating in accordance with AASHTO HB 17.

3.04 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

3.05 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in single duct run or duct bank on Project must be of same type.

3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
5. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch (19 mm).
6. Curves and Bends:
    a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
    b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch (1200 mm). Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
    c. Duct must have maximum of 180 degrees of bends between pull points.
7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
    a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch (300 mm) below grade or floor level and do not terminate in hubs.
8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above 104 deg F (40 deg C). Where environmental temperatures are calculated to rise above 104 deg F (40 deg C), and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of 104 deg F (40 deg C).
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inch (250 mm) o.c. for 5 inch (125 mm) duct, and vary proportionately for other duct sizes.
    a. Begin change from regular spacing to end-bell spacing 10 ft (3 m) from end bell, without reducing duct slope and without forming trap in line.
    b. Grout end bells into structure walls from both sides to provide watertight entrances.
10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inch (150 mm) o.c. for 4 inch (100 mm) duct, and vary proportionately for other duct sizes.
    a. Begin change from regular spacing to terminator spacing 10 ft (3 m) from terminator, without reducing duct line slope and without forming trap in line.

11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft (3 m) outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
    a. Couple steel elbows to ducts with adapters designed for this purpose and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig (1.03 MPa) hydrostatic pressure.
14. Pulling Cord: Install 200 lbf (1000 N) test nylon cord in empty ducts.
15. Concrete-Encased Ducts and Duct Bank:
    a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes 6 inch (150 mm) or less in nominal diameter.
    b. Width: Excavate trench 3 inch (75 mm) wider than duct on each side.
    c. Depth: Install so top of duct envelope is at least 24 inch (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inch (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
    d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
    e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
    f. Minimum Space between Ducts: 3 inch (75 mm) between edge of duct and exterior envelope wall, 2 inch (50 mm) between ducts for like services, and 4 inch (100 mm) between power and communications ducts.
    g. Elbows:
        1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
        2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.
    h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of equipment base.
        1) Stub-ups must terminate in coupling installed flush with be minimum 4 inch (100 mm) above finished floor and minimum 3 inch (75 mm) from conduit side to edge of slab.

i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
   1) Stub-ups must terminate in coupling installed flush with be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of slab.

j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

l. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts.

m. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of duct.

n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
   1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
   2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch (15 mm) reinforcing-rod dowels extending minimum of 18 inch (450 mm) into concrete on both sides of joint near corners of envelope.

o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct- installation application.

16. Direct-Buried Duct and Duct Bank:
   a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch (150 mm) in nominal diameter.
   b. Width: Excavate trench 3 inch (75 mm) wider than duct on each side.
   c. Depth: Install top of duct at least 36 inch (900 mm) below finished grade unless otherwise indicated.
   d. Set elevation of top of duct bank below frost line.
   e. Place minimum 3 inch (75 mm) of sand as bed for duct. Place sand to minimum of 6 inch (150 mm) above top level of duct.
   f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

h. Install duct with minimum of 3 inch (75 mm) between ducts for like services and 6 inch (150 mm) between power and communications duct.

i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.
   1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete.
   2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
      a) Stub-ups must terminate in coupling installed flush with be minimum 4 inch (100 mm) above finished base and minimum 3 inch (75 mm) from conduit side to edge of base.
   3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
   4) Stub-ups through interior floors must terminate in coupling installed flush with be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of equipment pad or floor slab.

k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inch (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

17. Warning Planks: Bury warning planks approximately 12 inch (300 mm) above direct-buried duct, placing them 36 inch (900 mm) o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional planks 12 inch (300 mm) apart, horizontally across width of ducts.

18. Underground-Line Warning Tape: Bury nonconducting conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inch (300 mm) above concrete-encased duct and duct banks and approximately 12 inch (300 mm) below grade. Align tape parallel to and within 3 inch (75 mm) of centerline of duct bank. Provide additional warning tape for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional tapes 12 inch (300 mm) apart, horizontally across width of ducts.
19. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:
1. Coordinate installation of new products with existing conditions.

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:
1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
1. Cast-in-Place Manholes:
a. Finish interior surfaces with smooth-troweled finish.
b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inch (38 to 50 mm) thick, arranged as indicated.
c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
2. Precast Concrete Handholes and Manholes:
a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch (25 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
3. Elevations:
a. Manhole Roof: Install with rooftop at least 15 inch (375 mm) below finished grade.
b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
c. Install handholes with bottom below frost line, below grade.
d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   b. Install chimney, constructed of precast concrete] collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.
6. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in " Section 071354 "Thermoplastic Sheet Waterproofing". After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inch (97 mm) for manholes and 2 inch (50 mm) for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
11. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:
   1. Coordinate installation of new products with existing conditions.

3.07 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:
   1. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
   1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
   2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.

3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below frost line, below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth.
   a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
   b. Dimensions: 10 inch wide by 12 inch deep (250 mm wide by 300 mm deep).
8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Interfaces with Other Work:
   1. Coordinate installation of new products for with existing conditions.

3.08 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect], Tenant, and authorities having jurisdiction.

B. Tests and Inspections:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
   2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch (300 mm) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
   3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

C. Nonconforming Work:
   1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
   2. Correct deficiencies and retest as specified above to demonstrate compliance.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:
   1. Engage factory-authorized service representative to support supervise field tests and inspections.

3.09 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.
   1. Sweep floor, removing dirt and debris.
   2. Remove foreign material.

END OF SECTION

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.
5. Pourable sealants.
6. Foam sealants.

B. Related Requirements:
1. Section 26 0500 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 07 8413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.02 ACTION SUBMITTALS

A. A. Product Data: For each type of product

PART 2 - PRODUCTS

2.01 ROUND SLEEVES

A. Wall Sleeves, Steel:
1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Wall Sleeves, Cast Iron:
1. Description: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Pipe Sleeves, PVC:
1. Description: ASTM D1785, Schedule 40.

D. Molded Sleeves, PVC:
   1. Description: With nailing flange for attaching to wooden forms.

E. Molded Sleeves, PE or PP:
   1. Description: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sheet Metal Sleeves, Galvanized Steel, Round:
   1. Description: Galvanized-steel sheet; thickness not less than 0.0239 inch (0.6 mm); round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.02 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
   1. Description:
      a. Material: Galvanized sheet steel.
      b. Minimum Metal Thickness:
         1) For sleeve cross-section rectangle perimeter less than 50 inch (1270 mm) and with no side larger than 16 inch (400 mm), thickness must be 0.052 inch (1.3 mm).
         2) For sleeve cross-section rectangle perimeter not less than 50 inch (1270 mm) or with one or more sides larger than 16 inch (400 mm), thickness must be 0.138 inch (3.5 mm).

2.03 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non- fire-rated walls or floors.
   1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
   2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.05 POURABLE SEALANTS

A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Sustainability Criteria:

2.06 FOAM SEALANTS

A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

B. Sustainability Criteria.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry- Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
      b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch (50 mm) above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:
1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.03 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION

SECTION 26 05 48- VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Delegated Design: Performance specifications for bidder-designed vibration and seismic controls for electrical systems, including the provision of stamped/sealed shop drawings and associated calculations.
   2. Basic materials specifications, including:
      a. Elastomeric isolation pads.
      b. Restraints - rigid type.
      c. Restraints - cable type.
      d. Restraint accessories.
      e. Post-Installed concrete anchors.
      f. Concrete inserts.
   3. Requirements for installation.

B. Related Requirements
   1. Section 26 0529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load capacity for each seismic-restraint device.
   2. Illustrate or indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an evaluation service member of an agency acceptable to authorities having jurisdiction.
   4. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:
   1. Detail fabrication and assembly of equipment bases.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
   a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
   b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
   c. Seismic Design Calculations: Submit input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
2. Seismic-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
3. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.03 INFORMATIONAL SUBMITTALS

A. A.Field quality-control reports.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: UL product listing or an agency acceptable to authorities having jurisdiction.

B. Consequential Damage: Provide additional seismic restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

C. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke- developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

D. Component Supports:
   1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.02 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
   1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   2. Size: Factory or field cut to match requirements of supported equipment.
   3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
   4. Surface Pattern: Smooth, ribbed, or waffle pattern.

2.03 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.04 RESTRAINTS - CABLE TYPE

A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables where concealed above ceilings or other architectural finishes; ASTM A492 stainless steel cables where exposed. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.05 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and] [restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.06 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:
1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:
1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications.
1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.
1. Undercut expansion anchors are permitted.

2.07 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

B. Comply with MSS SP-58.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Indicate on shop drawings, in schedules, or a combination of both, the locations where hanger rods for individual raceways, bus duct, cable trays, and hanger rods for trapeze hangers require hanger-rod stiffeners. Install where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

3.03 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

A. Install equipment and devices to withstand the effects of earthquake motions. Provide seismic restraint devices for systems and equipment where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:
1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: Anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect, Owner/Tenant representative, and authorities having jurisdiction.

B. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

C. Nonconforming Work:
1. Seismic controls will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Labels.
   2. Bands and tubes.
   3. Tapes and stencils.
   4. Tags.
   5. Signs.
   6. Cable ties.
   7. Miscellaneous identification products.

B. Related Requirements:
   1. Section 26 0050 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

A. Product Data:
   1. Includeconstruction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:

1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft (2.3 m) above finished floor.

C. Signs, labels, and tags required for personnel safety must comply with the following standards:
1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

D. Comply with NFPA 70E and Section 260573.19"Arc-Flash Hazard Analysis"

E. requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 1000 V or Less:
1. Black letters on orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
2. Colors for 208Y/120 V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
3. Colors for 240 V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
4. Colors for 480Y/277 V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.

5. Color for Neutral: White or gray.
6. Color for Equipment Grounds: Bare copper, Green, or Green with yellow stripe.
7. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Raceways and Cables Carrying Circuits at More Than 1000 V:
1. Black letters on orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:
1. Identify system voltage with black letters on orange background.

E. Warning labels and signs must include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

F. Equipment Identification Labels:
1. Black letters on white field.

2.03 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3 mil (0.08 mm) thick, polyester flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
2. Marker for Labels:
a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3 mil (0.08 mm) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
a. 1-1/2 by 6 inch (37 by 150 mm) for raceway and conductors.
b. 3-1/2 by 5 inch (76 by 127 mm) for equipment.
c. As required by authorities having jurisdiction.

2.04 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F (93 deg C). Comply with UL 224.

2.05 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil (0.08 mm) thick by 1 to 2 inch (25 to 50 mm) wide; compounded for outdoor use.

C. Tape and Stencil: 4 inch (100 mm) wide black stripes on 10 inch (250 mm) centers placed diagonally over orange background and are 12 inch (300 mm) wide. Stop stripes at legends.

D. Floor Marking Tape: 2 inch (50 mm) wide, 5 mil (0.125 mm) pressure-sensitive vinyl tape, with black and white or yellow and black stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
   1. Tape:
      a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
      b. Printing on tape must be permanent and may not be damaged by burial operations.
      c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
   2. Color and Printing:
      a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
      b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW"
      c. Inscriptions for Orange Tapes: "CAUTION BURIED COMMUNICATION LINE BELOW".
   3. Tape Type I:
      a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
      b. Width: 3 inch (75 mm).
      c. Thickness: 4 mil (0.1 mm).
      d. Weight: 18.5 lb/1000 sq. ft (9.0 kg/100 sq. m).

e. Tensile in accordance with ASTM D882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).

4. Tape Type II:
   a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
   b. Width: 3 inch (75 mm).
   c. Thickness: 12 mil (0.3 mm).
   d. d. Weight: 36.1 lb/1000 sq. ft (17.6 kg/100 sq. m).
   e. e. Tensile in accordance with ASTM D882: 400 lbf (1780 N) and 11,500 psi (79.2 MPa).
5. Tape Type ID:
   a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
   b. Width: 3 inch (75 mm).
   c. Overall Thickness: 5 mil (0.125 mm).
   d. Foil Core Thickness: 0.35 mil (8.9 µm).
   e. e. Weight: 28 lb/1000 sq. ft (13.7 kg/100 sq. m).
   f. f. Tensile in accordance with ASTM D882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).
6. Tape Type IID :
   a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
   b. Width: 3 inch (75 mm).
   c. Overall Thickness: 8 mil (0.2 mm).
   d. Foil Core Thickness: 0.35 mil (8.9 µm).
   e. e. Weight: 34 lb/1000 sq. ft (16.6 kg/100 sq. m).
   f. f. Tensile in accordance with ASTM D882: 300 lbf (1334 N) and 12,500 psi (86.1 MPa).

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch (25 mm).

2.06 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch (0.58 mm) thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:
1. Polyester Tags: 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags:
a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.07 SIGNS

A. Baked-Enamel Signs:
1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4 inch (6.4 mm) grommets in corners for mounting.
3. Nominal Size: 7 by 10 inch (180 by 250 mm).

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch (1 mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4 inch (6.4 mm) grommets in corners for mounting.
3. Nominal Size: 10 by 14 inch (250 by 360 mm).

C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
2. Thickness:
a. For signs up to 20 sq. inch (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
b. For signs larger than 20 sq. inch (129 sq. cm), 1/8 inch (3.2 mm) thick.
c. Engraved legend with black letters on white face.
d. Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.08 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 1000 V: Identification must completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for load shedding.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
   3. "UPS."

M. Vinyl Wraparound Labels:
   1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
   2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

N. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

P. Self-Adhesive Labels:
   1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high label; where two lines of text are required, use labels 2 inch (50 mm) high.

Q. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
   1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

W. Underground Line Warning Tape:
   1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inch (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds 16 inch (400 mm) overall.
   2. Limit use of underground-line warning tape to direct-buried cables.
   3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:
   1. Place in location with high visibility and accessibility.
   2. Secure using UV-stabilized, plenum-rated cable ties.

Y. Nonmetallic Preprinted Tags:
   1. Place in location with high visibility and accessibility.
   2. Secure using UV-stabilized plenum-rated cable ties.

Z. Write-on Tags:
   1. Place in location with high visibility and accessibility.
   2. Secure using UV-stabilized plenum-rated cable ties.

AA. Baked-Enamel Signs:
   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
   2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on minimum 1-1/2 inch (38 mm) high sign; where two lines of text are required, use signs minimum 2 inch (50 mm) high.

BB. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.

CC. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.03 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch (75 mm) high, black letters on 20 inch (500 mm) centers.
1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10 ft (3 m) maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 1000 V: Snap-around color-coding bands for raceway and cables].
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl tape applied in bands.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

F. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
   3. "UPS."

G. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify phase.
   1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

H. Power-Circuit Conductor Identification, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with conductor designation.

K. Conductors to Be Extended in Future: Attach marker tape to conductors and list source.

L. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

N. Concealed Raceways and Duct Banks, More Than 1000 V, within Buildings: Apply floor marking tape to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inch (300 mm) of floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.

O. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

P. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:

R. Baked-enamel warning signs.
   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
      a. Power-transfer switches.
      b. Controls with external control power connections.

S. Arc Flash Warning Labeling: Self-adhesive labels.

T. Operating Instruction Signs: Baked-enamel warning signs Metal-backed.

U. Emergency Operating Instruction Signs: Baked-enamel warning signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for load shedding.

V. Equipment Identification Labels:
   1. Indoor Equipment: Baked-enamel signs.
   2. Outdoor Equipment: Stenciled legend 4 inch (100 mm) high.
   3. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchgear.
      e. Switchboards.
      f. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
      g. Substations.
      h. Emergency system boxes and enclosures.
      i. Motor-control centers.
      j. Enclosed switches.
      k. Enclosed circuit breakers.
      l. Enclosed controllers.
      m. Variable-speed controllers.
      n. Push-button stations.
      o. Power-transfer equipment.
      p. Contactors.
      q. Remote-controlled switches, dimmer modules, and control devices.
      r. Battery-inverter units.

s. Battery racks.
t. Power-generating units.
u. Monitoring and control equipment.
v. UPS equipment.

END OF SECTION

SECTION 26 05 73.13 - SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.

B. Related Requirements:
1. Section 26 0010 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 0573.16 "Coordination Studies" for overcurrent protective device coordination studies.
3. Section 26 0573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.02 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

F. Single-Line Diagram: See "One-Line Diagram."

1.03 ACTION SUBMITTALS

A. Product Data:
1. For power system analysis software to be used for studies.

B. Short-Circuit Study Report:
   1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.
      a. Short-circuit study input data, including completed computer program input data sheets.
      b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
      c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.05 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE

A. Comply with IEEE 399 and IEEE 551.

B. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.

D. Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.

E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.02 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:
   1. Protective device designations and ampere ratings.
   2. Conductor types, sizes, and lengths.
   3. Transformer kVA and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
   6. Derating factors and environmental conditions.
   7. Any revisions to electrical equipment required by study.

D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

E. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
   2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
   3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
   5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:
   1. One-line diagram of system being studied.
   2. Power sources available.
   3. Manufacturer, model, and interrupting rating of protective devices.
   4. Conductors.
   5. Transformer data.

G. Short-Circuit Study Output Reports:
   1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated fault-current magnitude and angle.

c. Fault-point X/R ratio.
d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. Calculated asymmetrical fault currents:
      1) Based on fault-point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

PART 3 - EXECUTION

3.01 POWER SYSTEM DATA

A. Obtain data necessary for conduct of study.
   1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
   2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
   3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.

B. Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
   1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Obtain electrical power utility impedance at service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.02 SHORT-CIRCUIT STUDY

A. Perform study following general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:
1. To normal system low-voltage load buses where fault current is 5 kA or less.
2. Exclude equipment supplied by single transformer smaller than 75 kVA

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

I. Include in report identification of protective device applied outside its capacity.

END OF SECTION

SECTION 26 05 73.16 - COORDINATION STUDIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
a. Study results must be used to determine coordination of series-rated devices.

B. Related Requirements:
1. Section 26 0500 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 0573.13 "Short-Circuit Studies" for fault-current studies.
3. Section 26 0573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.02 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when abnormal current flow exists and then removes the affected portion of the circuit from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

F. Single-Line Diagram: See "One-Line Diagram."

1.03 ACTION SUBMITTALS

A. Product Data:
   1. For power system analysis software to be used for studies.

B. Coordination Study Report:
   1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.
      a. Coordination-study input data, including completed computer program input data sheets.
      b. Study and equipment evaluation reports.
      c. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
      d. Revised one-line diagram, reflecting field investigation results and results of coordination study.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.05 QUALITY ASSURANCE

A. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.06 REGULATORY AGENCY APPROVALS

A. Submittals for coordination study requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.

B. Submittals for coordination study require action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 POWER SYSTEM ANALYSIS SOFTWARE

A. Comply with IEEE 242 and IEEE 399.

B. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program must be capable of plotting and diagramming time- current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
   1. Optional Features:
      a. Arcing faults.
      b. Simultaneous faults.
      c. Explicit negative sequence.
      d. Mutual coupling in zero sequence.

D. Computer program must be designed to perform coordination studies or have function, component, or add-on module designed to perform coordination studies.

E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.02 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:
   1. Protective device designations and ampere ratings.
   2. Conductor types, sizes, and lengths.
   3. Transformer kVA and voltage ratings.
   4. Motor and generator designations and kVA ratings.
   5. Switchgear, switchboard, motor-control center, and panelboard designations.
   6. Revisions to electrical equipment required by study.
   7. Study Input Data: As described in "Power System Data" Article.
      a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:
   1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.
      a. Phase and Ground Relays:
         1) Device tag.
         2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
         3) Recommendations on improved relaying systems, if applicable.
      b. Circuit Breakers:
         1) Adjustable pickups and time delays (long time, short time, and ground).
         2) Adjustable time-current characteristic.
         3) Adjustable instantaneous pickup.
         4) Recommendations on improved trip systems, if applicable.
      c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:
   1. Device tag and title, one-line diagram with legend identifying portion of system covered.
   2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
   3. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
   4. Plot the following listed characteristic curves, as applicable:
      a. Power utility's overcurrent protective device.
      b. Medium-voltage equipment overcurrent relays.
      c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
      d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
      e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
      f. Cables and conductors damage curves.
      g. Ground-fault protective devices.
      h. Motor-starting characteristics and motor damage points.
      i. Generator short-circuit decrement curve and generator damage point.
      j. Largest feeder circuit breaker in each motor-control center and panelboard.
   5. Maintain selectivity for tripping currents caused by overloads.
   6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.

7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA

A. Obtain data necessary for conduct of overcurrent protective device study.
   1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
   2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
   3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers must be in accordance with NFPA 70E.

B. Gather and tabulate required input data to support coordination study. List below is guide. Comply with recommendations in IEEE 551 for amount of detail required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
   1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Electrical power utility impedance at service.
   3. Power sources and ties.
   4. Short-circuit current at each system bus (three phase and line to ground).
   5. Full-load current of loads.
   6. Voltage level at each bus.
   7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
   8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.03 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at service, extending down to system overcurrent protective devices as follows:
   1. To normal system low-voltage load buses where fault current is 5 kA or less.
   2. Exclude equipment supplied by single transformer smaller than 75 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:
   1. Device must not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:
   1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
   2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current

J. Generator Protection: Select protection according to manufacturer's instructions and to IEEE 242.

K. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems.

Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
   1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short-circuit ratings.
   2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
   3. Applicationof series-rated devices must be recertified, complying with requirements in NFPA 70.
   4. Include in report identification of protective device applied outside its capacity.

3.04 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:
   1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
   2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
   3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.05 MOTOR-STARTING STUDY

A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.

B. Prepare motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect operation of other utilization equipment on system supplying motor.

3.06 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified medium-voltage and low-voltage electrical testing and inspecting agency.
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

END OF SECTION

SECTION 26 05 73.19 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements:
1. Section 26 0010 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 0573.13 "Short-Circuit Studies" for fault-current studies.
3. Section 26 0573.16 "Coordination Studies" for overcurrent protective device coordination studies.

1.02 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed, and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.

E. SCCR: Short-circuit current rating.

F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

G. Single-Line Diagram: See "One-Line Diagram."

1.03 ACTION SUBMITTALS

A. Product Data:
   1. For power system analysis software to be used for studies.

B. Study Submittals:
   1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:
      a. Arc-flash study input data, including completed computer program input data sheets.
      b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
      c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.04 INFORMATIONAL SUBMITTALS

A. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.05 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.06 REGULATORY AGENCY APPROVALS

A. Submittals for arc-flash hazard analysis requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.

B. Submittals for arc-flash hazard analysis require action by Architect prior to submitting for approval by authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

D. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.02 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:
1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:
a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.

d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

H. Incident Energy and Flash Protection Boundary Calculations:
1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.03 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch (76 by 127 mm) self-adhesive equipment label for each work location included in analysis.

B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:
1. Location designation.
2. Nominal voltage.
3. Protection boundaries.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Arc flash PPE category.
8. Required minimum arc rating of PPE in Cal/cm squared.
9. Available incident energy.
10. Working distance.
11. Engineering report number, revision number, and issue date.

C. Labels must be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.02 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform Short-Circuit and Protective Device Coordination studies prior to starting Arc-Flash Hazard Analysis or obtain results from another source.
   1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
   2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.
   1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
   2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
   3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
   4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment fed from transformers smaller than 75 kVA.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:
   1. Fault contribution from induction motors must not be considered beyond three to five cycles.

2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:
1. When circuit breaker is in separate enclosure.
2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.03 POWER SYSTEM DATA

A. Obtain data necessary for conduct of arc-flash hazard analysis.
1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing study, and must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.

9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.04 LABELING

A. Apply one arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below not fed by single transformer smaller than 75 kVA must have arc-flash label applied to it:
   1. Medium-voltage switchgear.
   2. Medium-voltage switches.
   3. Medium voltage transformers.
   4. Switchboards.
   5. Panelboards.
   6. Low voltage transformers.
   7. Safety switches.
   8. Control panels.

C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.
   1. Indicate arc-flash energy.
   2. Indicate protection level required.

3.05 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION

SECTION 26 0923 LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Electronic time switches.
2. Electromechanical dial-time switches.
3. Outdoor photoelectric switches, solid state, flexible mounting.
4. Outdoor photoelectric switches, solid state, luminaire-mounted.
5. Outdoor photoelectric switches, low voltage.
6. Daylight-harvesting switching controls.
7. Daylight-harvesting dimming controls, analog.
8. Daylight-harvesting dimming controls, digital.
9. Indoor occupancy and vacancy sensors.
10. Switchbox-mounted occupancy sensors.
11. Digital timer light switch.
12. High-bay occupancy sensors.
13. Extreme-temperature occupancy sensors.
14. Outdoor motion sensors.
15. Lighting contactors.
16. Emergency shunt relay.
17. Conductors and cables.

B. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.02 ACTION SUBMITTALS

A. Product Data:
1. For each type of product.

B. Shop Drawings:
1. Show installation details for the following:
a. Occupancy sensors.
b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.03 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.04 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of lighting control software.
      b. Faulty operation of lighting control devices.
   2. Extended Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 ELECTRONIC TIME SWITCHES

A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
   1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. Contact Configuration: SPST
   3. Contact Rating: 20 A ballast load, 120/240 V(ac).
   4. Programs:
   5. Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the daily operation on holidays.
   6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
   7. Astronomic Time: All channels.
   8. Automatic daylight savings time changeover.
   9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.02 ELECTROMECHANICAL DIAL-TIME SWITCHES

A. Electromechanical-Dial Time Switches: Comply with UL 917.
   1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. Contact Configuration: SPST
   3. Contact Rating: 20 A ballast load, 120/240 V(ac).

4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
5. Astronomic time dial.
6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
7. Skip-a-day mode.
8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.03 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Description: Solid state, with SPST dry contacts rated for 1000 W, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
   1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn- on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
   3. Time Delay: Fifteen-second minimum, to prevent false operation.
   4. Surge Protection: Metal-oxide varistor.
   5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.
   6. Failure Mode: Luminaire stays ON.

2.04 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

A. Description: Solid state, with SPST dry contacts rated for 1000 W, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.
   1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn- on and turn-off levels within that range.
   3. Time Delay: Thirty-second minimum, to prevent false operation.
   4. Lightning Arrester: Air-gap type.
   5. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.
   6. Failure Mode: Luminaire stays ON.

2.05 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. Description: Solid state; one set of NO dry contacts rated for 24 V(ac) at 1 A, to operate connected load, complying with UL 773, and compatible with luminaire.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn- on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Mounting: 1/2 inch (13 mm) threaded male conduit.
5. Failure Mode: Luminaire stays ON.
6. Power Pack:
   a. Digital controller capable of accepting four 8PSJ inputs with two outputs rated for 20 A LED load at 120 and 277 V(ac), for 13 A LED at 120 and 277 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), Class 2 power source.
      1) With integral current monitoring.
      2) Compatible with digital addressable lighting interface.
      3) Plenum rated.

2.06 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Description: System operates indoor lighting.

B. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present.
      b. When significant daylight is present (target level).
      c. System programming is done with two hand-held, remote-control tools.

C. Ceiling-Mounted Switching Controls:
   1. Solid-state, light-level sensor unit, with **integrated** power pack, that detects changes in indoor lighting levels that are perceived by the eye.

B. Electrical Components, Devices, and Accessories:
   1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Sensor Output: Digital signal compatible with power pack.
   4. Sensor type: Closed loop.
   5. Zone: Multi.
   6. Power Pack:
      a. Digital controller capable of accepting 4 8PSJ inputs with two outputs rated for 20 A LED load at 120 and 277 V(ac), for 13 A LED at 120 and 277 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.
         1) With integral current monitoring
         2) Compatible with digital addressable lighting interface.
         3) Plenum rated.
   7. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.

8. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lx), with an adjustment for turn-on and turn-off levels within that range.
9. Skylight Sensors Light-Level Monitoring Range: 1000 to 10 000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
10. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
11. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
12. Test Mode: User selectable, overriding programmed time delay to allow settings check.
13. Control Load Status: User selectable to confirm that load wiring is correct.
14. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.07 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   1. Lighting control set point is based on the following two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:
   1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
   3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lx).

D. Power Pack: Digital controller capable of accepting four 8PSJ inputs with two output(s) rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc) Class 2 power source.

1. With integral current monitoring.
2. Compatible with digital addressable lighting interface.
3. Plenum rated.

2.08 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:
   1. Wall and/or Ceiling-mounted, solid-state indoor vacancy sensors.
   2. Dual technology.
   3. Integrated power pack.
   4. Hardwired connection to switch and BAS and lighting control system.
   5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   6. Operation:
      a. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   7. Sensor Output: Sensor is powered from the power pack.
   8. Power: Line voltage.
   9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
   10. Mounting:
      a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13 mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
   12. Bypass Switch: Override the "on" function in case of sensor failure.
   13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); turn lights off when selected lighting level is present.

B. Dual-Technology Type: Wall and/or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
   1. Sensitivity Adjustment: Separate for each sensing technology.
   2. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm) and detect a person of average size and weight moving not less than 12 inch (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inch/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96 inch (2440 mm) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180- degree pattern centered on the sensor over an area of 1000 sq. ft. (110 sq. m) when mounted 48 inch (1200 mm) above finished floor.

2.09 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application, and must comply with California Title 24.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Switch Rating: Not less than 800 VA LED load at 120 V, 1200 VA LED load at 277 V, and 800 W incandescent.

2.10 CONDUCTORS AND CABLE

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.03 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.04 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor

B. Label time switches and contactors with a unique designation.

3.05 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect.

B. Tests and Inspections:
   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:
1. Engage factory-authorized service representative to supervise field tests and inspections.

3.06 ADJUSTING

A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.07 MAINTENANCE

A. Software and Firmware Service Agreement:
1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for two years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION

SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Related Requirements:
   1. Section 26 0500 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.02 ACTION SUBMITTALS

A. Product Data:
   1. For each type of product.
      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
      b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:
   1. Field quality-control reports.

1.03 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
   1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:
   1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
   2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.03 DISTRIBUTION TRANSFORMERS

A. Option in first paragraph below may not be available from manufacturers and is only applicable to single- and three-phase transformers greater than 10 kVA.

B. Comply with NFPA 70 and list and label as complying with UL 1561.

C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
   1. One leg per phase.
   2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.
   3. Grounded to enclosure.

D. Coils: Continuous windings without splices except for taps.
   1. Coil Material: Copper.
   2. Internal Coil Connections: Brazed or pressure type.
   3. Terminal Connections: Bolted.

E. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

F. Enclosure: Ventilated.
   1. Core and coil must be encapsulated within resin compound using vacuum- pressure impregnation process to seal out moisture and air.
   2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
   3. Wiring Compartment: Sized for conduit entry and wiring installation.
   4. Environmental Protection:
      a. Indoor: UL 50E, Type 2.
      b. Outdoor: UL 50E, Type 3R.
   5. Finish Color: Gray weather-resistant enamel.

G. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.

L. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

M. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for non-sinusoidal load current-handling capability to degree defined by designated K-factor.
   1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.
   2. Indicate value of K-factor on transformer nameplate.
   3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.

N. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding shield.

O. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

P. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by qualified structural professional engineer.

Q. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
   1. 9.00 kVA and Less: 40 dB(A-weighted)
   2. 9.01 to 30.00 kVA: 45 dB(A-weighted)
   3. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9, and 48 dB(A-weighted) for K-factors of 13 and 20.
   4. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9, and 53 dB(A-weighted) for K-factors of 13 and 20.
   5. 150.01 to 300.00 kVA: 55 dB(A-weighted) for K-factors of 1, 4, and 9, and 58 dB(A-weighted) for K-factors of 13 and 20.
   6. 300.01 to 500.00 kVA: 60 dB(A-weighted) for K-factors of 1, 4, and 9, and 63 dB(A-weighted) for K-factors of 13 and 20.
   7. 500.01 to 700.00 kVA: 62 dB(A-weighted) for K-factors of 1, 4, and 9, and 65 dB(A-weighted) for K-factors of 13 and 20.

2.04 IDENTIFICATION

A. Nameplates:
   1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."
   2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 26 0553 "Identification for Electrical Systems."

2.05 SOURCE QUALITY CONTROL

A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.

B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of qualified electrical testing laboratory's certification of system compliance on control units.
   1. Resistance measurements of windings at rated voltage connections and at tap connections.
   2. Ratio tests at rated voltage connections and at tap connections.
   3. Phase relation and polarity tests at rated voltage connections.
   4. No load losses, and excitation current and rated voltage at rated voltage connections.
   5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
   6. Applied and induced tensile tests.
   7. Regulation and efficiency at rated load and voltage.
   8. Insulation-Resistance Tests:
      a. Line-side to ground.
      b. Load-side to ground.
      c. Line-side to load-side.
   9. Temperature tests.
   10. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

C. Nonconforming Work:
   1. System equipment that does not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

A. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer
B. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by qualified structural professional engineer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
   2. Brace wall-mounted transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base in accordance with manufacturer's published instructions.

E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.03 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.04 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

B. Field tests and inspections must be witnessed by architect and authorities having jurisdiction.

C. Tests and Inspections:
1. Small (Upto 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:
   a. Visual and Mechanical Inspection.
      1) Inspect physical and mechanical condition.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify that resilient mounts are free and that shipping brackets have been removed.
      4) Verify that unit is clean.
      5) Perform specific inspections and mechanical tests recommended by manufacturer.
      6) Verify that as-left tap connections are as specified.
      7) Verify presence of surge arresters and that their ratings are as specified.
   b. Electrical Tests:
      1) Measure resistance at windings, taps, and bolted connections.
      2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
      3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
      4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
2. Large (Larger Than 167 kVA Single Phase or 500 kVA Three Phase) Dry-Type Transformer Field Tests:
   a. Visual and Mechanical Inspection:
      1) Inspect physical and mechanical condition.
      2) Inspect anchorage, alignment, and grounding.
      3) Verify that resilient mounts are free and that shipping brackets have been removed.
      4) Verify that unit is clean.
      5) Perform specific inspections and mechanical tests recommended by manufacturer.
      6) Verify that as-left tap connections are as specified.

7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:
   1) Measure resistance at windings, taps, and bolted connections.
   2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
   3) Perform power-factor or dissipation-factor tests on windings.
   4) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
   5) Perform excitation-current test on each phase.
   6) Perform applied voltage test on line- and load-side windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
   7) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

E. Nonconforming Work:
   1. Transformer will be considered defective if it does not pass tests and inspections.
   2. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Assemble and submit test and inspection reports.

G. Manufacturer Services:
   1. Engage factory-authorized service representative to supervise field tests and inspections.

3.05 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.06 CLEANING

A. A.Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.07 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.
   1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
   3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Related Requirements
1. Section 26 0573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.03 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) connect factory-installed space heaters to temporary electrical service to prevent condensation.

C. Handle and prepare switchboards for installation according to NECA 400 NEMA PB 2.1.

1.09 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

C. Unusual Service Conditions: NEMA PB 2, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC- ES AC156.
   2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 SWITCHBOARDS

A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 2.

E. Comply with NFPA 70.

F. Comply with UL 891.

G. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

H. Front- and Side-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Section Alignment: Front aligned.

I. Front- and Rear-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Fixed, individually mounted.
   3. Sections front and rear aligned.

J. Nominal System Voltage: 480Y/277 V 208Y/120 V.

K. Main-Bus Continuous: 4000 A.

L. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC- ES AC156.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

M. Indoor Enclosures: Steel, NEMA 250, Type 1.

N. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray

O. finish over a rust-inhibiting primer on treated metal surface.

P. Outdoor Enclosures: Type 3R, with interior-lighted walk-in aisle.
   1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
   2. Enclosure: Downward, rearward sloping roof; rear hinged doors for each section, with provisions for padlocking.
   3. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for cylinder lock. At least one door shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
   4. Accessories: LED luminaires, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.
   5. Walk-in Aisle Heating and Ventilating:
      a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F (5 deg C) with outside design temperature of 0 deg F (minus 18 deg C).
      b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F (38 deg C) with outside design temperature of 90 deg F (32 deg C).
      c. Ventilating openings complete with replaceable fiberglass air filters.
      d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer, with spare capacity of 25 percent, within the switchboard. Supply voltage shall be 120/208 V ac.
7. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

Q. Barriers: Between adjacent switchboard sections.

R. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

S. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
2. Space-Heater Power Source: 120-V external branch circuit.

T. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

U. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers, or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

V. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

W. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

X. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.

Y. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Z. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

AA. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity,
   3. silver-plated.
   4. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
   5. Copper feeder circuit-breaker line connections.
   6. Tin-plated aluminum feeder circuit-breaker line connections.
   7. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
   8. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) Minimum-size required by UL 891, hard- drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.
   9. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   10. Disconnect Links:
      a. Isolate neutral bus from incoming neutral conductors.
      b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
   11. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
   12. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
   13. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

BB. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

CC. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

DD. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.03 SURGE PROTECTION DEVICES

A. SPDs: Comply with UL 1449, Type 1.

B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.

C. Features and Accessories:
1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
5. Surge counter.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V , three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V.
2. Line to Ground: 1000 V.
3. Line to Line: 1000 V.

G. SCCR: Equal or exceed 200 Ka.

H. Nominal Rating: 20 kA.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   4. Instantaneous trip.
   5. Long- and short-time pickup levels.
   6. Long- and short-time adjustments.
   7. Ground-fault pickup level, time delay, and I squared t response.
   8. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   9. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter- style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   10. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
   11. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   12. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
      f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
      g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75
      h. percent of rated voltage.
      i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

j. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
k. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
a. Instantaneous trip.
b. Time adjustments for long- and short-time pickup.
c. Ground-fault pickup level, time delay, and I squared t response.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 120-V ac.

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
3. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground- fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no- trip" mode is selected).

6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.
1. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
3. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground- fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.05 FUSES ARE SPECIFIED IN SECTION 262813 "FUSES."

2.06 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:
   1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, tapped double secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
   2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
   3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
   4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
      d. Megawatts: Plus or minus 1 percent.
      e. Megavars: Plus or minus 1 percent.
      f. Power Factor: Plus or minus 1 percent.
      g. Frequency: Plus or minus 0.1 percent.
      h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
      i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
      j. Contact devices to operate remote impulse-totalizing demand meter.
   2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Analog Meters:
   1. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.

D. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

E. Instrument Switches: Rotary type with off position.
   1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
   2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

F. Ammeters: 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

G. Watt-Hour Meters and Wattmeters:
1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

H. Impulse-Totalizing Demand Meter:
1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording five -minute integrated demand of totalized system.

2.07 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Circuits: 120-V ac, supplied from remote branch circuit.

C. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

D. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

E. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.08 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

F. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.09 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.
   1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.
   1. Nameplate: At least 0.0625-inch- (1.588 mm-) thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.

C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
   1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
   2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
   3. Protect from moisture, dust, dirt, and debris during storage and installation.
   4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in- Place Concrete."
   1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to switchboards.

6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

H. Set field-adjustable switches and circuit-breaker trip ranges.

I. Install spare-fuse cabinet.

J. Comply with NECA 1.

3.03 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting, and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTRO

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.
   1. Tests and Inspections:
   2. Acceptance Testing:
      a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
      b. Test continuity of each circuit.
   3. Test ground-fault protection of equipment for service equipment per NFPA 70.
   4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   5. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   6. Perform the following infrared scan tests and inspections, and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
      d. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.07 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

1.03 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.
1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details.

2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
      b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
   1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5 Type 12.
   2. Height: 84 inches (2.13 m) maximum.
   3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
   5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   7. Finishes:
      a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Same finish as panels and trim.

c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Incoming Mains:
1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
   1. Percentage of Future Space Capacity: 20 percent.

L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series- connected short-circuit rating.
   1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
   1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.03 POWER PANELBOARDS

A. Panelboards: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

G. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. External Control-Power Source: 120-V branch circuit.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker or lugs only.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

E. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. External Control-Power Source: 120-V branch circuit.

G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

H. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

I. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.
   1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.05 LOAD CENTERS

A. Load Centers: Comply with UL 67.

B. Mains: Circuit breaker or lugs only.

C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

E. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.06 ELECTRONIC-GRADE PANELBOARDS

A. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

C. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

D. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. SPD.
1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
2. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
    a. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    b. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    c. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    d. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.
3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
    a. Line to Neutral: 700 V.
    b. Line to Ground: 700 V.
    c. Neutral to Ground: 700 V.
    d. Line to Line: 1200 V.
4. SCCR: Equal to the SCCR of the panelboard in which installed
5. Nominal Rating: 10 kA.

F. Buses:
1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.07 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers:
   2. Inverse time-current element for low-level overloads.
   3. Instantaneous magnetic trip element for short circuits.
   4. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   5. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field- adjustable trip setting.
   6. Electronic Trip Circuit Breakers:
      a. RMS sensing.
      b. Field-replaceable rating plug or electronic trip.
      c. Digital display of settings, trip targets, and indicated metering displays.
      d. Multi-button keypad to access programmable functions and monitored data.
      e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
      f. Integral test jack for connection to portable test set or laptop computer.
      g. Field-Adjustable Settings:
         1) Instantaneous trip.
         2) Long- and short-time pickup levels.
         3) Long and short time adjustments.
         4) Ground-fault pickup level, time delay, and I squared T response.
   7. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   8. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
   9. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
   10. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
   11. Subfeed Circuit Breakers: Vertically mounted.
   12. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Breaker handle indicates tripped status.
      c. UL listed for reverse connection without restrictive line or load ratings.
      d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
      f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      g. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and

control system specified in Section 260913 "Electrical Power Monitoring and Control."

h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
k. Auxiliary Contacts: Two, SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
o. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories:
a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.08 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.09 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:
   1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
   3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each

panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.06 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

B. Related Requirements:
1. Section 26 0923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.

1.02 ALLOWANCES

A. A.See Section 01 2100 "Allowances" for description of allowances affecting items specified in this Section.

1.03 UNIT PRICES

A. A.See Section 01 2200 "Unit Prices" for description of unit prices affecting items specified in this Section.

1.04 ALTERNATES

A. A.See Section 01 2300 "Alternates" for description of alternates affecting items specified in this Section.

1.05 DEFINITIONS

A. Do not duplicate common acronyms, abbreviations, and terms defined in Section 260500 "Basic Electrical Requirements."

B. Retain terms that remain after this Section has been edited for a project. Include only essential definitions or acronyms not well understood by the affected industry or trade.

C. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

D. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

1.06 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Preinstallation Coordination Meeting(s): For ceiling-mounted cable reels. Conduct meeting as videoconference or at Project site.
   1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections. Notify Architect, Construction Manager, and Owner's Commissioning Authority of scheduled meeting dates.

1.07 ACTION SUBMITTALS

A. Product Data:
   1. Toggle switches.
   2. Key lock switches.
   3. Maintained-contact switches.
   4. Momentary-contact switches.
   5. Rocker switches.
   6. Dimmer switches.
   7. Fan-speed controllers.
   8. Single straight-blade receptacles
   9. Duplex straight-blade receptacles.
   10. Duplex straight-blade receptacles with integral switching means.
   11. Receptacles with AFCI device.
   12. Receptacles with AFCI and GFCI devices.
   13. Receptacles with GFCI device.
   14. Locking receptacles.
   15. Pin-and-sleeve receptacles.
   16. Spring-driven commercial/industrial-use cord reels.
   17. Cord reels for use in hazardous locations.
   18. Cord connectors.

B. Shop Drawings:
   1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

1.08 INFORMATIONAL SUBMITTALS

A. Retain "Manufacturers' Instructions" Paragraph below when execution requirements state "in accordance with manufacturer's instructions," especially if those instructions may require preinstallation review and coordination with Construction Documents to verify constructability and commissioning requirements.

B. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
   1. Dimmers.
   2. Fan-speed controllers.
   3. Single straight-blade receptacles.
   4. Duplex straight-blade receptacles.
   5. Duplex straight-blade receptacles with integral switching means.
   6. Receptacles with AFCI device.
   7. Receptacles with AFCI and GFCI devices.
   8. Receptacles with GFCI device.
   9. Locking receptacles.
   10. Pin-and-sleeve receptacles.
   11. Spring-driven commercial/industrial-use cord reels.
   12. Cord reels for use in hazardous locations.

C. Sample warranties.

1.09 CLOSEOUT SUBMITTALS

A. Sustainable Design Closeout Documentation.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Items: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Extra Keys for Key Lock Switches: One of each kind.
   2. SPD Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than one unit.
   3. Controlled Receptacles: Equal to 10 percent of quantity installed for each kind specified, but no fewer than one unit.
   4. Cord Connectors: One of each kind.

B. Special tools are items that would not be available from a typical hardware store.

C. Special Tools:
   1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.
   2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

1.11 WARRANTY FOR DEVICES

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
   1. Extended Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.
   2. Follow-On Extended Warranty Period: Eight years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board destination, freight prepaid.

PART 2 - PRODUCTS

2.01 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch :
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN WMUZ and UL 20.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.
      b. Configuration:
         1) General-duty, 120-277 V, 15 A, single pole.
         2) General-duty, 120-277 V, 20 A, single pole.
         3) Extra-heavy-duty, 120-277 V, 15 A, single pole.
         4) Extra-heavy-duty, 120-277 V, 20 A, single pole.
         5) Extra-heavy-duty, 120-277 V, 30 A, single pole.
   4. Accessories:
      a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
      b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Toggle Switch with Forked Key Lock :
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN WMUZ and UL 20.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.

b. Configuration:
1) Retain one of three subparagraphs below.
2) 120-277 V, 15 A, single pole.
3) 120-277 V, 20 A, single pole.
4) 120-277 V, 30 A, single pole.

C. Rocker Switch:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN WMUZ and UL 20.
3. Options:
a. Device Color: As indicated on architectural Drawings.
b. Configuration:
1) 120-277 V, 15 A, single pole.
2) 120-277 V, 20 A, single pole.
4. Accessories:
a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Rocker Switch with Nightlight:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN WMUZ and UL 20.
3. Options:
a. Device Color: As indicated on architectural Drawings.
b. Configuration: 120-277 V, 20 A, single pole.
4. Accessories:
a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Type I Dimmer Switch:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. General Characteristics:
   a. Reference Standards: UL CCN EOYX and UL 1472 Type I dimmer.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
   b. Switch Style: Rocker.
   c. Dimming Control Style: Slide.
4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Air-Gap Fan-Speed Controller Switch:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN GQHG and UL 1917.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.02 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
   b. Configuration:
      1) General-duty, NEMA 5-20R and NEMA 5-20R.
      2) General-duty, NEMA 6-30R and NEMA 6-50R.
      3) Heavy-duty, NEMA 5-30R and NEMA 5-50R.
      4) Heavy-duty, NEMA 6-30R and NEMA 6-50R.
      5) Extra-heavy-duty, NEMA 5-20R.

4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
   a. Finish: Nickel plated.
   b. Configuration: Recessed, smooth wallplate; NEMA 5-15R and NEMA 5- 20R.

C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN RTRT and UL 498.
   b. Configuration: NEMA 5-15R.
3. Options:
   a. Finish: Nickel plated.

2.03 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
   b. Configuration:
      1) General-duty, NEMA 5-15R and NEMA 5-20R.
      2) General-duty, NEMA 6 -20R.
      3) Heavy-duty, NEMA 5-15R and NEMA 5-20R.
      4) Heavy-duty, NEMA 6-20R.
      5) Extra-heavy-duty, NEMA 5-15R and NEMA 5-20R.
      6) Extra-heavy-duty, NEMA 6-20R.

4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Tamper-Resistant Duplex Straight-Blade Receptacle:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
   b. Configuration:
      1) General-duty, NEMA 5-15R and NEMA 5-20R.
      2) Heavy-duty, NEMA 5-15R and NEMA 5-20R.
      3) Extra-heavy-duty, NEMA 5-15R and NEMA 5-20R.
4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. Isolated Ground Duplex Straight-Blade Receptacle:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
   b. Configuration:
      1) General-duty, NEMA 5-15R and NEMA 5-20R.
      2) Heavy-duty, NEMA 5-15R and NEMA 5-20R.
      3) Extra-heavy-duty, NEMA 5-15R and NEMA 5-20R.
      4) Extra heavy-duty, NEMA 6-20R.
4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Isolated Ground Duplex Straight-Blade Receptacle with Type 3 Surge Protective Device:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards:
         1) UL CCN RTRT and UL 498.
         2) Surge Protective Devices: UL 1449, Type 3.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.
         1) Configuration: Heavy-duty, smooth face, NEMA 5-15R and NEMA 5- 20R.
   4. Accessories:
      a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
      b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN RTRT and UL 498.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.
      b. Configuration:
         1) General-duty, NEMA 5-15R and NEMA 5-20R; two USB-A ports.
         2) General-duty, NEMA 5-15R and NEMA 5-20R; two USB-C ports.
         3) General-duty, NEMA 5-15R and NEMA 5-20R; one USB-A port; one USB-C port.
         4) General-duty, smooth face, two USB-A ports.
         5) General-duty, smooth face, four USB-A ports.
   4. Accessories:
      a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
      b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Wired Full-Controlled Duplex Straight-Blade Receptacle:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN RTXI and UL Subject 498B.
3. Options:
a. Device Color: As indicated on architectural Drawings.
1) Configuration: NEMA 5-15R and NEMA 5-20R.
4. Accessories:
a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

G. Wired Half-Controlled Duplex Straight-Blade Receptacle:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN RTXI and UL Subject 498B.
3. Options:
a. Device Color: As indicated on architectural Drawings.
1) Configuration: NEMA 5-15R and NEMA 5-20R.
4. Accessories:
a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.04 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI Device:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.
3. Options:
a. Device Color: As indicated on architectural Drawings.
1) Configuration: Heavy-duty, NEMA 5-15R and NEMA 5-20R.

4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with AFCI and GFCI Device:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
      1) Configuration: Heavy-duty, NEMA 5-15R and NEMA 5-20R.
4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
1. Regulatory Requirements:
   a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
   a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
3. Options:
   a. Device Color: As indicated on architectural Drawings.
      1) Configuration: Heavy-duty, NEMA 5-15R and NEMA 5-20R.
4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.
         1) Configuration: Heavy-duty, NEMA 5-15R and NEMA 5-20R.
   4. Accessories:
      a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
      b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.
         1) Configuration: Heavy-duty, NEMA 5-15R and NEMA 5-20R.
   4. Accessories:
      a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
      b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Hospital-Grade, Isolated Ground, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
   3. Options:
      a. Device Color: As indicated on architectural Drawings.
         1) Configuration: Heavy-duty, NEMA 5-15R and NEMA 5-20R.

4. Accessories:
   a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
   b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.05 LOCKING RECEPTACLES

A. NEMA, 125 V, Locking Receptacle:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN RTRT and UL 498.
   3. Options:
      a. Device Color: Black with yellow voltage indication on face.
      b. Configuration: 2 pole, 3 wire, grounding, NEMA L5-15R, NEMA L5-20R, and NEMA L5-30R.

B. NEMA, 125 V, Isolated Ground Locking Receptacle:
   1. Regulatory Requirements:
   2. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   3. General Characteristics:
      a. Reference Standards: UL CCN RTRT and UL 498.
   4. Options:
      a. Device Color: Black with yellow voltage indication on face.
      b. Configuration: 2 pole, 3 wire, grounding, NEMA L5-15R, NEMA L5-20R, and NEMA L5-30R.

C. NEMA, 250 V, Locking Receptacle:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      a. Reference Standards: UL CCN RTRT and UL 498.

D. Options:
      a. Device Color: Black with blue voltage indication on face.
      b. Configuration:
         1) 2 pole, 3 wire, grounding, NEMA L6-15R, NEMA L6-20R, and NEMA L6-30R.

E. NEMA, 250 V, Isolated Ground Locking Receptacle:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN RTRT and UL 498.
3. Options:
a. Device Color: Black with blue voltage indication on face.
b. Configuration:
1) 2 pole, 3 wire, grounding, NEMA L6-15R, NEMA L6-20R, and NEMA L6-30R.

2.06 PIN-AND-SLEEVE RECEPTACLES

A. C2 Series, 125/250 V, Pin-and-Sleeve Receptacles:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN QLIW, UL 1682, and UL 1686.
b. Series: UL 1686 C2 and IEC 60309-2 Series II.
c. Voltage Rating: 125/250 V.
3. Options:
a. Configuration:
1) 3 pole, 4 wire, 100 A, IP67.
2) 4 pole, 5 wire, 100 A, IP67.

B. C2 Series, 480 V, Pin-and-Sleeve Receptacles:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
a. Reference Standards: UL CCN QLIW, UL 1682, and UL 1686.
b. Series: UL 1686 C2 and IEC 60309-2 Series II.
c. Voltage Rating: 480 V.
3. Options:
a. Configuration:
1) 3 pole, 4 wire, 100 A, IP67.
2) 4 pole, 5 wire, 100 A, IP67.

2.07 SPECIAL-PURPOSE POWER OUTLET ASSEMBLIES

A. Ceiling-Mounted, Wall-Mounted, and Floor-Mounted Power Outlet Cord Management Assembly:
   1. Source Limitations: Obtain all components for each power outlet cord management assembly from single manufacturer.
   2. Regulatory Requirements: Components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   3. General Characteristics: Provide the following specified products with fabricated power outlet cord management assembly:
      a. Cord Management System:
         1) Spring-driven commercial/industrial-use cord reel, 12 AWG conductors.
         2) Cord reel for use in Class I Group D hazardous location.
      b. Termination Fitting:
         1) Owner-furnished fitting.
         2) Outdoor-use, watertight, sealed cord connector.

B. Spring-Driven Commercial/Industrial-Use Cord Reel, No. 12 AWG Conductors:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. General Characteristics:
      b. Reference Standards: UL CCN SBCV and UL 355.
      c. Spring take-up retraction mechanism.
   3. Options:
      d. Electrical Rating with Cable: 600 V, 20 A.
      e. Color: As indicated by architect.
      f. Enclosure Degree of Protection: Type 4.
      g. Ball stop.
      h. Pivot base.
      i. Spool Capacity:
         1) No. 12 AWG, two wires and equipment ground, 20 ft (6 m).

2.08 CONNECTORS, CORDS, AND PLUGS

A. Outdoor-Use, Watertight, Sealed Cord Connector:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
   2. General Characteristics:
      b. Reference Standards: UL CCN AXUT and UL 498.
   3. Options:
      c. Configuration:
         1) NEMA 5-15 with diagnostic LED indicator.
         2) NEMA 5-20 with diagnostic LED indicator.

3) NEMA 6-15.
4) NEMA 6-20.
5) NEMA L5-15.
6) NEMA L5-20 with diagnostic LED indicator.
7) NEMA L5-30.
8) NEMA L6-15.
9) NEMA L6-20.
10) NEMA L6-30.
11) NEMA L7-15.
12) NEMA L7-20.
13) NEMA L7-30.
14) NEMA L14-20.
15) NEMA L14-30.
16) NEMA L15-20.
17) NEMA L15-30.
18) NEMA L16-20.
19) NEMA L16-30.
20) NEMA L17-30.
21) NEMA L18-30.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receptacles:
   1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels:
   2. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.
   3. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
   4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

3.03 SELECTION OF GFCI RECEPTACLES

A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.04 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Architect for resolution of conflicting requirements.

C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering and provide durable wire markers or tags inside device box or outlet box.
b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

D. Interfaces with Other Work:
1. Coordinate installation of new products with existing conditions.

3.05 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
5. Consult Architect for resolution of conflicting requirements.

C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering and provide durable wire markers or tags inside device box or outlet box.
b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

D. Interfaces with Other Work:
   1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
   2. Coordinate installation of new products with existing conditions.

3.06 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:
   1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
   2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
   3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
   4. Consult Architect for resolution of conflicting requirements.

C. Identification:
   1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
      a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering and provide durable wire markers or tags inside device box or outlet box.
      b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

D. Interfaces with Other Work:
   1. Coordinate installation of new products with existing conditions.

3.07 INSTALLATION OF PIN-AND-SLEEVE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:
   1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
   2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
   3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in UL 1686.
   4. Consult Architect for resolution of conflicting requirements.

C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

D. Interfaces with Other Work:
1. Coordinate installation of new products with existing conditions

3.08 INSTALLATION OF CORD REELS AND FITTINGS

A. Comply with manufacturer's instructions.

B. Special Techniques:

C. Interfaces with Other Work:
1. Coordinate installation of new products with existing conditions.

3.09 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

A. Comply with manufacturer's instructions.

B. Reference Standards:
1. Consult Architect for resolution of conflicting requirements.

C. Interfaces with Other Work:
1. Coordinate with Section 262726.43 "Special-Purpose Power Outlet Assemblies" for installation of connectors and cords on fabricated power-outlet cord management assemblies.
2. Coordinate installation of new products with existing conditions.

3.10 FIELD QUALITY CONTROL OF SWITCHES

A. Testing Preparation:

B. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

C. Tests and Inspections:
1. Perform tests and inspections in accordance with manufacturers' instructions.

D. Nonconforming Work:
1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:
1. Engage factory-authorized service representative to supervise field tests and inspections.

3.11 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Testing Preparation:
1. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

B. Tests and Inspections:
1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:
1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:
1. Engage factory-authorized service representative to supervise field tests and inspections.

3.12 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Testing Preparation:

B. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

C. Tests and Inspections:
1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.

5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

D. Nonconforming Work:
1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:
1. Engage factory-authorized service representative to supervise field tests and inspections.

3.13 FIELD QUALITY CONTROL OF PIN-AND-SLEEVE RECEPTACLES

A. Testing Preparation:

B. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

C. Tests and Inspections:
1. Insert and remove test plug to verify that device is securely mounted.
2. Measure line voltage.
3. Measure percent voltage drop.
4. Measure ground impedance, which must be not greater than 2 ohms.
5. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

D. Nonconforming Work:
1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:
1. Engage factory-authorized service representative to supervise field tests and inspections.

3.14 FIELD QUALITY CONTROL OF CORD REELS AND FITTINGS

A. Testing Preparation:

B. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

C. Tests and Inspections:
   1. Perform tests and inspections indicated in manufacturer's instructions.

D. Nonconforming Work:
   1. Components and assemblies will be considered defective if they do not pass tests and inspections.
   2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:
   1. Engage factory-authorized service representative to supervise field tests and inspections.

3.15 FIELD QUALITY CONTROL OF CONNECTORS, CORDS, AND PLUGS

A. Testing Preparation:

B. Field tests and inspections must be witnessed by Architect and authorities having jurisdiction.

C. Tests and Inspections:
   1. Perform tests and inspections indicated in manufacturer's instructions.

D. Nonconforming Work:
   1. Unit will be considered defective if it does not pass tests and inspections.
   2. Remove and replace defective units and retest.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:
   1. Engage factory-authorized service representative to supervise field tests and inspections.

3.16 SYSTEM STARTUP FOR SWITCHES

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

3.17 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than- normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly and lubricate as recommended in writing by manufacturer.

3.18 PROTECTION

A. Devices:
1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Cord Reels and Fittings:
1. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

C. Connectors, Cords, and Plugs:
1. After installation, protect connectors, cords, and plugs from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 31 00 – PHOTOVOLTAIC COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. PV system description.
2. Manufactured PV units.
3. PV module framing.
4. PV array construction.
5. Inverters.
6. System overcurrent protection.
7. Mounting structures.

1.3 DEFINITIONS

A. CEC: California Energy Commission.

B. ETFE: Ethylene tetrafluoroethylene.

C. FEP: Fluorinated ethylene propylene.

D. IP Code: Required ingress protection to comply with IEC 60529.

E. MPPT: Maximum power point tracking.

F. PTC: PVUSA Test Condition. Commonly regarded as a “real-world” measure of PV output. See below for definition of “PVUSA.”

G. PV: Photovoltaic.

H. PVUSA: Photovoltaics for Utility Systems Applications.

I. STC: Standard Test Conditions defined in IEC 61215.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For PV modules.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly.
   4. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
   1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:
      a. Faulty operation of PV modules.
      b. Faulty operation of Inverter
   2. Warranty Period: Five years from date of Substantial Completion.

B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
   1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:

a. Specified minimum power output to 80 percent or more, for a period of 25 years.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. PV Module: Canadian Solar Co. Ltd. - TOPBiHiKu7 CS7N-720TB-AG
   2. Inverter: SolarEdge – S6-GC33K-US

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Seismic Qualification Certificates: For inverters, distribution boards, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

2.3 PV CAPACITIES AND CHARACTERISTICS

A. Minimum Electrical Characteristics:
   1. Nominal Power (Pnom): 720W
   2. Power Tolerance: +5/-3%
   3. Average Panel Efficiency: 23.2%
   4. Rated Voltage (Vmpp): 40.8V
   5. Rated Current (Impp): 17.67A
   6. Open-Circuit Voltage (Voc): 48.7V
   7. Short-Circuit Current (Isc): 18.69A
   8. Maximum System Voltage: 1500V
   9. Maximum Series Fuse: 35A
   10. Power Temperature Coefficient: -0.29%/C
   11. Voltage Temperature Coefficient: -0.25%/C
   12. Current Temperature Coefficient: 0.05%/C

2.4 PV SYSTEMS DESCRIPTION

A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and supplying power to a distributed network.
   1. System Components:
      a. PV modules.
      b. Array frame.
      c. Utility-interactive inverter.
      d. Overcurrent protection, disconnect, and rapid shutdown devices.
      e. Mounting structure.
      f. Utility meter.

2.5 MANUFACTURED PV UNITS

A. Cell Materials: Polycrystalline.
   1. TOPCon Cell

B. Module Construction:
   1. Nominal Size: 93.9 inches wide by 51.3 inches long.
   2. Weight: 83.3 lb.

C. Encapsulant: Ethyl vinyl acetate.

D. Front and Back Panel: High-transmission tempered anti-reflective tempered glass.

E. Backing Material: Polyester film.
   1. Color: White.

F. Bypass Diode Protection: Internal.

G. Junction Box:
   1. Size: 1.56 by 3.96 by 0.52 inch.
   2. Fully potted, vandal resistant.
   3. IP Code: IP67.
   4. Flammability Test: UL 1703.

H. Output Cabling:
   1. 0.158 inch.
   2. Quick, multiconnect, polarized connectors.
   3. Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.

I. Series Fuse Rating: 35A.

2.6 PV MODULE FRAMING

A. PV laminates mounted in anodized extruded-aluminum frames.
   1. Entire assembly UL Listed for electrical and fire safety, according to UL 1703, and complying with IEC 61215.
   2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
   3. Finish: Anodized aluminum.
      a. Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
      b. Color: As indicated by manufacturer's designations.

2.7 PV ARRAY CONSTRUCTION

A. Framing: Solar Wedge, 2" tall rail by Professional Solar products Inc attached to stanchion posts.
   1. Material: Extruded aluminum.
   2. Maximum System Weight: Less than 4 lb/sq. ft.
   3. Raceway Cover Plates: Aluminum.
   4. One degree tilt.

B. Flat-Roof Mounting:
   1. Wind-tunnel tested to 120-mph wind.
   2. Service Life: 20 years.
   3. Freestanding system, attached to stanchion posts.

2.8 INVERTER

A. Inverter Type: Central.

B. Control Type: Maximum power point tracker control.

C. Inverter Electrical Characteristics:
   1. Rated AC Power Output: 33000 VA
   2. Maximum AC Power Output: 33000 VA
   3. Maximum Continuous Output Current per Phase: 40A
   4. THD: Less than 3%
   5. Maximum DC Power: 33000W
   6. Maximum Input Current: 40Adc
   7. Maximum Input Short Circuit Current 63Adc

D. Operating Conditions:
   1. Operating Ambient Temperatures: Minus 13 to plus 140 deg F.
   2. Storage Temperature: Minus 13 to plus 140 deg F.
   3. Relative Humidity: Zero to 100 percent, noncondensing.

E. Charge controllers shall have the following:
   1. Overcurrent protection.
   2. Generator input breaker box.
   3. Automatic transfer relay.
   4. Digital display.
   5. Transformer.
   6. Disconnect switch.
   7. Shunt controller.
   8. Shunt regulator.
   9. Surge overload protection.

F. Enclosure:
   1. NEMA 250, Type 3R.
   2. Enclosure Material: Galvanized steel.
   3. Cooling Methods:
      a. Passive cooling.
   4. Protective Functions:
      a. AC over/undervoltage.
      b. AC over/underfrequency.
      c. Ground overcurrent.
      d. Overtemperature.
      e. AC and DC overcurrent.
      f. DC overvoltage.
      g. DC polarity.
      h. Surge protection.
      i. AFCI
      j. Integrated DC and AC switches
   5. Standard LCD user display.

G. Disconnects: Rated for system voltage and conductor.

H. Regulatory Approvals:
   1. IEEE 1547.1.
   2. IEEE 1547.3.
   3. UL 1741.
   4.

2.9 PERFORMANCE METER

A. The system shall include a California Energy Commission approved performance meter as specified on plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of PV panels with roof assembly and other construction.

C. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.

D. Install weatherseal fittings and flanges where PV panel assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 07 92 00 “Joint Sealants” for materials and application.

E. Seismic Restraints: Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 “Seismic Controls for Electric Systems.”

F. Wiring Method: Install cables in raceways.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.

B. Coordinate installation of utility-interactive meter with utility.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.4 FIELD TESTS

A. Complete testing of the installed system shall be performed by a factory-certified representative prior to system start up. All required modifications shall be made and system signed off.

B. Grounding: Grounding shall conform to Section 26 05 26.

3.5 UTILITY INTERCONNECT

A. Contractor shall coordinate with the utility company to provide all grid intertie requirements and process all required paper work per utility company requirements.

END OF SECTION

SECTION 26 55 61 - THEATRICAL LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. This specification section includes the engineering, fabrication, furnishing, delivery, and installation of new theatrical stage lighting equipment as specified in the 'Products' specifications and as indicated on the related stage lighting drawing documents for the auditorium stage.

B. Contract Documents and General Requirements apply to the work of this Section.

C. All bidders shall fully inform themselves of the conditions under which the work is to be performed. No additional compensation shall be allowed for any labor or item the bidder could have been fully informed of prior to the bid date.

D. While the components, quantities, and arrangements described herein and shown on the drawings indicate specific details for the realization of the stage systems, bidders may propose alternate details and components that will fulfill the functional parameters of the envisioned system. In such event, bidders shall submit a complete set of specifications and drawings, not less detailed than these and following the same general outline, together with a detailed statement indicating paragraph by paragraph wherein the equipment to be offered deviates from specifications included in this bid request. Where alternate proposals are offered they shall be submitted with the amount to be added or deducted from the base bid which is required from all bidders.

1.02 SCOPE OF WORK

A. Work under this section consists of the installation of all materials and equipment necessary for the proper operation of all stage lighting equipment. Installation contractor shall furnish qualified personnel to test and adjust the equipment after installation until specified performance is attained.

B. Preparation and submission of complete engineered shop drawings for approval by the Architect and Theatre Systems Consultant.

C. Verification of conditions and dimensions at the job site.

D. The adjustment and testing of the completed installation by the Contractor's personnel, subject to Architect and Theatre Systems Consultant's approval.

E. Submission of required record documents.

F. Coordination with other affected work, trades, and inspections.

G. Installation work includes, but is not limited to the following:
   1. New stage lighting relay and dimmer racks.

2. New stage lighting data distribution and lighting control processor racks.
3. New lighting control receptacle stations and low voltage control wiring.
4. New house lighting control stations and low voltage control wiring.
5. New stage manager's control panel and low voltage control wiring.
6. New worklight control stations and low voltage control wiring.
7. New lighting control DMX512 protocol wiring, low voltage house light, worklight, and rehearsal light wiring, Ethernet data wiring, and any additional new control wiring per the systems manufacturer's final shop drawings.
8. New circuitry distribution connector strips, plug boxes and wall boxes.
9. New stage lighting spotlight fixtures and followspots.
10. New stage lighting control console, remote focus unit, video monitors, and Ethernet nodes.
11. New power service, circuit protection, system conduit, raceways, junction boxes, pull boxes and related wiring as specified on the electrical drawings.
12. Installation and connection of system line voltage equipment and components.
13. The contractor shall furnish and install all low voltage stage lighting control wiring. The contractor shall coordinate with the stage lighting equipment manufacturer regarding the responsibility for termination of stage lighting control low voltage wiring.
14. Initial hanging and plugging of new portable stage lighting fixtures per the Theatre Systems Consultant's directive.
15. All scaffolding, hoisting equipment, ladders, man-lift devices, tools, etcetera necessary to perform the work.

H. The above scope of work is intended as a reference guide only and is not intended to define the limits of the work necessary for a complete installation. All labor, materials, and equipment necessary for the proper operation of all systems must be provided.

1.03 RELATED SECTIONS

A. Theatrical Stage Rigging and Drapery Equipment

B. Basic Electrical Requirements

C. Basic Electrical Materials

1.04 SYSTEMS INTEGRATOR

A. The Contractor shall utilize a System Integrator to coordinate and assist in the installation of all aspects of the theatrical lighting system as specified in this section. This shall include but not be limited to all dimming and control equipment as well as integration with the architectural lighting fixtures connected to the dimming and control system. The following companies have prior approval as System Integrator:

1. Polaris Lighting
   624 Irving Ave.
   Glendale, CA. 91201
   (818) 265-0330

2. Kinetic Lighting
   5435 W. San Fernando Rd.
   Los Angeles, CA. 90039
   (310) 837-3204

3. LVH Entertainment
   3685 Medford Street
   Los Angeles, CA. 90063
   (805) 278-4584

4. Westview Productions
   5350 Vivian St. Suite A
   Arvada, CO 80002
   (844) 987-7378

5. BCT Entertainment
   2780 East Regal Park Dr.
   Anaheim, CA. 92806
   (714) 237-9270

1.05 RESPONSIBILITY

A. Organize and program the Work of the Section to harmonize with the work which will be performed by other contractors during the Project so that work will proceed as expeditiously as possible.

B. The engineering, fabrication, installation, and coordination of systems and associated components specified in this Section are the Contractor's responsibility.

C. Comply with all applicable code requirements and the requirements of federal, state, and local authorities having jurisdiction over the design, fabrication, installation, and operation of the systems and associated components specified in this section.

D. Take full responsibility for the proper placing and fitting of equipment and materials furnished under this Section into the structure.

E. Design components and install equipment to fit into the structure as built.

F. Specifications only establish criteria and do not attempt to dictate specific details and methods that may be necessary for proper installation; drawings related to the Work of this Section may therefore be diagrammatic.

G. Become familiar with the building construction and finishes, access and space available for equipment, and obvious interferences requiring special attention.

H. Check and verify pertinent dimensions, sizes, loads, and the appropriateness of structure supporting the proposed Work of this Section, both on the Drawings and in the field before proceeding with any work.

I. Provide additional structural and support members and guards as necessary for proper installation and operation of the Work of this Section.

J. All stage lighting equipment and hardware must be of new and recent manufacture.

K. All components utilized in the stage lighting equipment shall be specifically recommended by their manufacturer or trade organization for stage lighting applications. They shall be installed and used in accordance with the manufacturer's specification.

L. Provide equipment, devices, machinery, and systems based upon the following:
1. Safety to personnel during operation, use, and maintenance.
2. Adequate strength.
3. Reliability, with consideration for special or unusual requirements of the unit or installation.
4. Ease of maintenance.
5. Coordination with associated and adjacent systems provided under other Sections.

1.06 CODES, LABELS, AND STANDARDS

A. All stage lighting equipment and installation methods must conform to current State rules and all local codes and ordinances.

B. All components shall be listed by Underwriters Laboratories (UL).

C. A manufacturer's label shall be conspicuously and permanently attached to each piece of stage lighting equipment.

D. Those parts of the stage lighting equipment that require maintenance shall be safely and easily accessible and serviceable.

E. Conform to the applicable requirements of the current editions of the following reference codes or standards:
1. National Electrical Code (NEC).
2. United States Institute for Theatre Technology (USITT).
3. Entertainment Services & Technology Association (ESTA).
4. American National Standards Institute (ANSI).

F. Where in these Specifications one certain kind, type, or brand of manufacturer or material is named, it shall be regarded as the required minimum standard of quality. Substitutions lowering performance, quality, method of assembly or installation, or in general, not in keeping with Drawings and Specifications will not be permitted. Only written approval of the Architect and Theatre Systems Consultant will permit substitution for materials specified. Where both catalog number and description is indicated, requirements of description shall take precedence and prevail.

1.07 QUALIFICATIONS

A. Provide the Work of this Section under a single contractor with a contractor widely experienced in providing and installing theatrical stage lighting equipment and related electrical hardware of the quality and complexity specified in this Section.

B. Maintain a competent Supervisor, acceptable to the School and the Architect, during the entire installation. Change of Supervisor during the Project is not acceptable without prior written approval from the School and the Architect.

C. Employ only experienced electricians and stage lighting technicians on the Project.

D. Employ only certified welders, if welding is required.

1.08 BIDS MUST INCLUDE

A. All equipment, labor, and services indicated in these specifications and in the related stage lighting drawing documents, including all necessary hardware, fittings, and components necessary for a full and complete system.

B. A schedule and time estimate for preparation, fabrication, equipment delivery, and installation.

C. A list of manufacturer's names, model and type numbers, and catalog data sheets covering all items included in the ‘PRODUCTS’ section of this document.

1.09 SUBMITTALS

A. Make submittals to the Architect per requirements in Division 1 for transmittal to their consultants.

B. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.

C. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions. All submittals shall be submitted in a timely manner in order to allow adequate time for review and resubmittal if necessary.

D. Submit and identify each shop drawing using both descriptive title and numeric or alphanumeric drawing number. Do not change drawing title or number after first submittal.

E. The review of shop drawings, brochures, and samples is general only and does not relieve Manufacturer or Contractor of responsibility for errors, equipment design responsibility, deviations from Drawings and Specifications, or conflict with other work which may result from such deviations.

F. The review of a separate item does not indicate review of the complete assembly in which it functions.

G. No work shall begin on fabrication of equipment until drawings are approved and returned to contractor. No material shall be shipped to job site until formally approved in writing.

1.10 PERMITS AND INSPECTIONS

A. Obtain and pay for required permits and inspections of Work of the Section.

B. Furnish material and Work under this Section that meets or exceeds applicable legal and code requirements.

C. Perform tests required by the Architect, School Representative, and authorities having jurisdiction.

1.11 SAFEGUARDS AND PROTECTION

A. Provide suitable barriers and warning signs associated with or adjacent to stage lighting installation wherever necessary for the protection or safety of workers on the Project, School's personnel, and others during construction. Maintain barriers and warning signs during installation of the Work of this Section.

B. Provide guards and guides at structural edges and corners and surrounding equipment as necessary to prevent fouling or tearing of adjacent theatrical equipment or contact with personnel.

C. Protect materials and equipment from dirt and damage. Cover materials until just before the completion of the Project to prevent the adhesion of foreign matter or unintended paint.

D. Replace damaged or defective work or material prior to final payment request.

E. Take full responsibility for loss or injury to persons or property resulting from neglect of the above precautions.

1.12 DELIVERY AND STORAGE OF MATERIALS

A. Contractor is responsible for the scheduling and timely delivery and placement of items furnished under this Section.

B. Clearly identify on each container the contents stored within.

1.13 RECORD DRAWINGS AND MANUALS

A. Within thirty days of final installation approval, provide to the Architect (6) copies of an 'Operating and Servicing Manual' for the Stage Lighting System. Provide (1) copy of the manual to the Theatre Systems Consultant. Each manual shall be bound in a hard cover binder and contain the following information:
   1. Final as-built shop drawings including updated equipment locations and conduit runs.
   2. Catalog data.

3. Operating and maintenance data.
4. Parts lists and source for parts and service.
5. Guarantees and warrantees.
6. Test reports.

B. Each complete manual shall include all instructions necessary for proper operation and servicing of the systems. The instructions must be written in a manner that easily describes the necessary day-to-day operating procedures.

1.14 SPARE PARTS

A. Provide spares, spare parts, and special tools for all stage lighting equipment if necessary for proper operation and maintenance of equipment.

1.15 COMPLETION

A. Provide all labor, engineering, design, testing, supervision, material and equipment required even though not specifically mentioned herein, so that when work is completed, an operable system will be turned over to the School. Any errors, omissions, or ambiguities are not to condition this requirement but shall be brought to the attention of the Owner in their possible effect on intent of this Specification.

B. Before operating any equipment for demonstration or test comply with manufacturer's preparation instructions.

C. Once equipment has been installed a factory authorized field service technician shall check and test equipment and make adjustments as necessary.

D. After checkout and adjustment, the stage lighting system shall be operated for approval of the School, Architect, and Theatre Systems Consultant.

E. If due to installation-caused matters the Architect or Theatre Systems Consultant are required to perform any follow-up checkout or inspection visits after the approved completion of the project, the Contractor shall compensate the Architect or Consultant at their standard hourly rates for all time expended.

1.16 WARRANTY

A. Guarantee all materials, equipment, and work against defects of any kind for a period of one year from written acceptance of the work.

B. Parts Warranty: Obtain guarantees and/or warrantees for factory assembled equipment and include with ‘Operations and Maintenance Data’.

C. Replacement: In the event of failure of any work, equipment, or device during the life of the guarantee, at no cost to the School, repair or replace the defective work and remove, replace, or restore any parts of the structure or building which may be damaged as the direct result of the defective work or in the course of making the replacement of defective work or materials. Any work, equipment, or device replaced due to failure shall be guaranteed for a period of one year from date of replacement.

D. Make a minimum of two inspections with operations personnel, within the warranty period, at no expense to the School, to insure all systems to be in satisfactory operating condition. Submit a written report signed by operating personnel witnessing inspection to the School indicating inspection results with copies to the Architect and Theatre Systems Consultant.

E. The Contractor shall provide field service maintenance, at no cost to the School, within 24 hours of notification of system malfunction. This service response shall be in effect for a period of 12 months after the School's acceptance of the system.

1.17 INSURANCE

A. Provide full insurance against loss or damage during equipment shipment, storage, installation, and testing.

PART 2 - PRODUCTS

2.01 DIMMING SYSTEM

A. DIMMER RACKS
1. The dimmer racks shall be designed specifically for entertainment lighting, and shall consist of 6, 12, 24, or 48 dimmer module spaces. Dimmer rack shall be UL listed.
2. Rack set-up and preset data shall, as standard, be fully user programmable on a per rack or system wide basis.
3. Dimmer rack shall be a modular, freestanding cabinet. Cabinet shall be a welded, heavy gauge steel framework and be fully enclosed with removable panels and include a hinged, locking door over dimmer section. The dimmer rack shall allow for adjacent or back-to-back mounting of multiple racks. The rack shall be constructed to permit insertion and removal of dimmers and control modules without the use of tools. Finish shall be baked enamel over a primed surface.
4. Dimmer racks shall operate at 120/208VAC 3 phase, 4 wire + ground 60 Hz at a maximum of 800A per phase. Bussing across adjacent multiple racks shall be possible.
5. Load phase, neutral, and ground terminals shall, as standard accept up to a #6 gauge wire. An optional terminal adapter accepting up to #2 gauge wire shall be provided to minimize load voltage losses. Dimmer racks shall be braced for 50,000 amps. Provisions shall be made for optional amp trap devices to provide higher fault current protection, if required.
6. Dimmer rack shall be designed for up to 48 dual plug-in modules. Each module shall contain two 2.4KW dimmers, nondims, constant voltage breakers or one dual-sized special purpose fluorescent dimmer, comprising a total of up to 96 dimmers per cabinet. Provide additional special purpose modules as defined herein. Provide dimmer modules as indicated on Drawings.
7. Dimmer modules shall rest on mounting trays with guide rails to align dimmer during insertion. Cabinet shall be shipped without dimmers or mounting trays installed for ease of installation.

8. All dimmer input power and control wiring shall be factory wired with terminated load wires to terminals adjacent to each dimmer receptacle. A neutral buss shall also be furnished in cabinet.
9. Ventilation shall be provided using multiple low-noise fans. The fans shall maintain the temperature of all components at proper operating levels with dimmers at any load. Air shall flow over the surfaces of the heat generating components using a combination of convection and fan assisted airflow. Each rack shall be outfitted with a lockable door that does not impede airflow in any manner. Fans shall operate only when the lighting control console is activated.
10. Load terminations shall be clearly marked with the rack circuit number. Signal terminations shall be by plug-in screw terminals to facilitate contracting and servicing and shall be clearly labeled.
11. Provide a label for each dimmer rack with rack ID# and circuit # range contained within rack. Label to be attached near top of rack with mechanical fasteners, adhesive only fastening is not acceptable.
12. Provide spare modules as noted in schedule of quantities on project drawings.

B. DIMMER RACK CONTROL ELECTRONICS
1. The main dimmer control electronics shall be housed in one processor plug-in module. The dimmer control electronics shall have a direct Ethernet connection and shall accept (2) DMX512 protocol inputs.
2. All rack setup and preset data shall be stored in a non-volatile manner and may be transferred to a replacement control processor module without losing data.
3. The dimmer system shall support the following range of peripherals:
   a. Remote backup preset panels.
   b. Remote hand held programmers.
   c. Remote panels for architectural style channel and preset control of separate and independent zones of lighting.
4. Dimmer rack control electronics shall have the provision to select any circuit in the rack for activation by a Panic function. Panic function shall be activated by a remote contact closure.
5. Dimmer rack control electronics shall contain provisions for mapping DMX512 addresses from any of the three control inputs to circuits in that rack. Control electronics shall also support setting of minimum and maximum output levels, dimmer curves, non-dim operation, and direct dimmer level setting.

C. DIMMER MODULES
1. The dimmer modules shall be fully plug-in and factory wired. Dimmer modules shall be of rugged and heavy-duty construction. Power and signal pins shall be recessed in a self-aligning housing to avoid handling, storage, and insertion damage. A contoured handle shall be provided for ease of insertion and withdrawal. All chassis parts, except heat sinks and handle, shall be properly treated, primed and finished in fine texture, scratch resistant, gray powder coat paint. Each module shall be labeled with the manufacturer’s name, catalog number and rating. Dimmer modules shall be UL recognized devices.
2. Dimmer modules shall be keyed so that dimmer modules of greater capacity shall not be interchangeable.
3. Each dimmer module shall contain one or two single pole circuit breakers, associated solid state switching modules, filters, power, and control components.

4. Dimmer electronics shall be completely solid state. They shall utilize two silicon controlled rectifiers in a back-to-back electrical configuration. The full load of the circuit is to be carried and controlled by the silicon controlled rectifiers.
5. Each dimmer shall be protected by a fully magnetic circuit breaker of the appropriate current rating and 10,000 AIC surge rating mounted on the face plate of the dimmer module so that the trip current is not affected by ambient or rack temperature. The circuit breaker shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current and shall disconnect the power to the dimmer module before damage can be done to the dimmer power components. The circuit breakers shall be rated for 100 percent switching duty applications and shall be a UL recognized device.
6. SSR devices shall be encapsulated, epoxy filled high impact plastic cases with optically isolated firing circuits, control circuitry, and two silicon controlled rectifiers (SCRs). There shall be a minimum of 2,500 volts RMS of isolation between the AC line and the control lines of the SSR.
7. The SSR shall be in an industry standard format that is easily field replaceable without removing any other electrical or electronic devices.
8. Each dimmer module shall have an integral inductive filter, minimum **500** micro-second rise time, to reduce the rate of current rise time resulting from the SSR switching on. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit the radio frequency interference on line and load conductors.
9. Special Purpose Modules
    a. Standard factory modules shall be available to provide dedicated nondim circuits utilizing mechanical relays and not employing SSR devices. Each nondim shall be provided with a primary circuit breaker of the appropriate rating. Nondims shall be designed so they can be used for inductive loads.
    b. Standard factory modules shall be available to provide hard fired output for use with neon, cold cathode, and fluorescent loads. Hard fired modules shall provide a current source independent of the load current for the SCR Gate Drive Signal. Hard fired dimmers shall function independent of load as a result and shall drive loads of 1 watt or less.
    c. Standard factory modules shall be available to provide constant 120VAC voltage irrespective of control signal to dimmer racks.
    d. Standard factory modules shall be available that are capable of functioning as a dimmer, relay, or constant voltage breaker on either half of a dual module. Either of the three functions can be mixed or matched on either half of the module. Dimmer or relay functions can be remotely configured from the stage lighting control console or from the dimmer rack processor. The constant voltage function shall be manually activated at the dimmer module without the need for configuration at the dimmer processor

D. RELAY RACKS
1. Relay racks shall be UL-listed enclosures containing 12, 24, or 48 pole breaker subpanels. Racks shall be constructed of 16 gauge galvanized steel and finished in a fine-textured scratch resistant paint.
2. Panel covers shall be available to support surface or flush mounting. Panel shall contain lockable door(s).
3. 1, 2, or 3-pole breakers or relays, up to 30A capacity, shall be supported in any combination within the panel.

a. Provide a 3-pole breaker for sense feed connection of ELTS per project drawings.

4. A control interface shall be provided for panel setup and monitoring. Indicators shall be provided for power status, DMX status, network status, and rack errors. The panel shall support DMX512 and Ethernet network (sACN) control signals. The control interface shall support a USB memory stick interface for upload of configurations and software updates.
   a. Control interface shall support recording and playback of user-configured presets.
   b. Presets shall be able to be recalled via an astronomical time clock. Up to 50 events shall be supported.
   c. Individual relays shall be capable of being assigned a discrete control address on a circuit-by-circuit basis without the requirement for sequential addressing beginning from a rack start address.
5. The control electronics shall report the following information per branch circuit:
   a. Breaker state (on/off and open/closed).
   b. Current draw (amps)
   c. Voltage.
   d. Energy usage.
6. Branch circuit breakers shall feature a high inrush trip curve and shall not trip at full load. Relays shall utilize an integral mechanically held air-gap relay. All breakers shall feature integral current sensing.
7. Provide means for connection of normal power sense feeds to other devices.
   a. Provide a 15A 3-pole circuit breaker for connection of EM sense feed from ELTS.
   b. Provide a bus bar mounted tap kit with fuse holder for connection of sense feed from EBDK.
8. A main breaker shall be an option to support the maximum feeder size for each size panel.
9. Basis of design: Electronic Theatre Controls Sensor IQ Series.

E. PORTABLE DIMMER DEVICES - 1 CHANNEL DIMMERS
1. Portable dimming modules shall be comprised of one 750 watt dimmers packaged in an enclosure suitable for mounting to the yoke of incandescent-lamped theatrical spotlights.
2. The dimming module enclosure shall include provisions for pipe mounting brackets as well as wall mounting brackets and shall contain handles for ease of carrying.
3. Each dimming module shall be powered by a 20A 120VAC one-phase electrical service.
4. The dimmers shall be compatible with the USITT DMX512/1990 control protocol and the dimming control input shall be optically isolated. Each dimmer module shall include 5-pin XLR DMX512 input and thru receptacles.
5. Each dimming module shall include a processor with local controls mounted on its enclosure. The functions available at the local controls shall include selection of the starting DMX address, setting dimmer levels.
6. Dimmer output voltage transition time shall be not less than 450 microseconds.
7. Dimming modules shall be convection cooled and shall operate without cooling fans or filters. Each dimming module shall produce little or no mechanical noise.
8. Dimmer modules shall be UL listed and labeled.

9. Provide each dimming module with the following accessories & options.
    a. Dimmer outputs shall be via 20A grounded stage pin connectors on flexible cable.
    b. 5-15P input connector on 12” long flexible cable attached to module.
    c. (1) 15’ portable DMX512 control extension cable with heavy-duty jacket and black Neutrik 5-pin XLR connectors with gold plated contacts (TMB ProPlex PC224P or equal). Provide DMX512 extension cable fabricated per criteria noted in the extension cable portion of this specification section.
    d. Pipe mounting hardware kit suitable for attachment to a theatrical fixture yoke.
10. Provide quantity and type of dimming modules and accessories as indicated in the schedule of quantities on Project Drawings.
11. Acceptable products:
    a. E.T.C. #ES750.
    b. Vari-Lite Lighting Light Pack dimmer

2.02 EMERGENCY LIGHTING & POWER DISTRIBUTION

A. EMERGENCY LIGHTING TRANSFER SYSTEMS

1. Provide (1) UL 1008 code rated emergency lighting transfer relay panel to switch dimmed and nondimmed lighting circuits to emergency power in the event that the normal power supply to the stage lighting system fails. Features include:
    a. The transfer panel shall provide dimmer pass-through for normal operation.
    b. The panel shall be wall or floor-mounted, separate from the dimmer racks.
    c. The transfer panel shall be configured to accept a single 120/208VAC 3-phase emergency power source or individual emergency branch circuits, type per project drawings. The source voltage settings shall be field adjustable for either single or three phase power.
    d. The panel shall have a quantity of 20-amp circuits for transfer switches sufficient to supply emergency power to all applicable circuits as indicated on electrical drawings.
    e. The panel shall have voltage sensing of normal supply lines and automatic retransfer of power on restoration of normal supply.
    f. An integral test switch shall be provided to simulate normal power source failure for periodic verification of system operation. The test switch shall be accessible without opening the panel.
2. Provide DMX Emergency Bypass Controller(s) to bypass the DMX control signal and drive all connected loads to full in a loss-of-power or emergency situation.
    a. Bypass controller shall accept a contact closure input that will drive a single universe of DMX512 to full or to a preset level when activated. Bypass controller shall not process the DMX512 signal when in Normal input mode.
    b. Bypass controller shall contain an LED indicator on exterior of unit signaling normal state or bypass state. Controller shall contain internally accessible DIP switches for configuration o DMX record mode, Contact Input Type, and Wait Time for Restore of incoming DMX.
3. Provide Emergency Bypass Detection Kit(s) for monitoring normal 3-phase power feed to dimming system and providing a maintained contact closure output upon loss of power to trigger other lighting bypass controller(s).
4. Connect normal power sense feeds in relay rack as required.
    a. Connect ELTS EM sense feed to a 15A 3-pole circuit breaker in relay rack.

b. Connect EBDK sense feed to a bus bar mounted tap kit with fuse holder in relay rack.

B. DIMMER-CIRCUIT DISTRIBUTION EQUIPMENT

1. Provide stage lighting circuitry connector strips and plug boxes as shown on the stage lighting drawing documents.
   a. Each connector strip and plug box shall be provided with screw terminal strips for feed connections, mounting bracket devices, and basket weave strain-relief multi-cable connectors where necessary.
2. Provide all necessary mounting hardware for pipe or surface mounted strips and boxes as detailed on project drawings.
3. Backboxes for all plug boxes shall be provided by stage lighting manufacturer unless noted otherwise on project drawings.
4. Plug boxes and plug strips shall have two sets of knockouts on each of the sides.
   a. Production dimmer and relay circuits shall utilize grounded stage pin connectors or 5-20R connectors as indicated on project drawings.
   b. Dimmable rehearsal light circuits and running light circuits shall utilize L5-20R connectors.
   c. Non-dimmable and non-switched 120VAC power shall be supplied to connector strips and plug boxes via pigtail or panel mount 5-20R receptacles.
   d. 208VAC circuits when implemented shall utilize L6-20R connectors.
5. Exterior finish shall be flat, black baked enamel. Custom colored finishes shall be required if indicated on project drawings.
6. Circuit identification numbers shall be securely affixed to face of plug boxes and to one or both sides of plug strips as indicated on project drawings. Numbers shall be engraved lamacoid tags, white letters on black background and shall be secured via rivets or other mechanical fasteners. Adhesive-only fastening is not acceptable. All labels shall be attached at the factory where distribution devices are fabricated.

C. COMPANY SWITCH

1. Provide Theatrical Systems Company Switch as described herein and as shown on Theatre Systems Consultant's Drawings and Electrical Drawings.
2. Company Switch configuration shall be 120/208V, 3-phase, 5-wire, amperage as noted on Project Drawings. Lighting System Company Switches rated 200A or greater shall have double neutrals.
3. Enclosure shall be a NEMA 1 wall mounted enclosure fabricated with a 14 ga. steel and finished in a black epoxy paint. The Company Switch must satisfy requirements of NFPA 70 Article 384 and Article 520. The Company Switch shall be UL listed and labeled.
4. Provide a front door panel to protect circuit breaker controls. There shall be no access to live electrical conductors when the door is open.
5. 3-phase, 120/208VAC company switch assemblies shall be provided with connectors by Cam-Lok, Leviton or equal, compatible with industry standard Cam-Lok E1016 devices, six connectors including double neutrals.
6. Company switch shall also contain a connection chamber for connection with bare wire to copper bus bars. Load connection busbars shall contain (2) 3/8"-16 x 1" bolts and (1) dual rated solderless lug for cable connection. When open, the hinged door shall trigger a shunt-trip mechanism that will trip the breaker.

7. Main breaker shall be UL listed, 3-pole, 100% equipment rated, continuous duty circuit breaker with a minimum AIC rating of 65,000A. Enclosure shall be Hi-Pot tested at 1250VAC for a period of no less than 10 seconds.
8. All connections from Main Circuit Breaker to output panel shall be by copper bus. All bus sizes shall be based on a current density no greater than 1,000 amperes per square inch.
9. All internal noncurrent-carrying metal parts shall be grounded to the main chassis frame.
10. Enclosure shall contain a neon indication lamp to indicate voltage present on each phase leg and a neon lamp to indicate ground integrity.
11. Company switch shall be labeled, 'THEATRICAL LIGHTING SYSTEMS COMPANY SWITCH' along with amperage.
12. Acceptable Manufacturers:
    a. Electronic Theatre Controls - Powersafe Pro
    b. Lex Products Corp.
    c. ESL Power Systems
    d. Others contingent on approval by Theatre Systems Consultant.

2.03 STAGE LIGHTING CONTROL SYSTEM

A. STAGE LIGHTING CONTROL DATA NETWORK DEVICES
1. Provide Ethernet and DMX512 data network control and distribution devices as described herein. All devices connected to the ethernet data network shall be compatible with the lighting control console and any other lighting control devices connected to the ethernet network. All connected ethernet devices shall support 10BaseT and utilize Neutrik EtherCon RJ-45 connectors for data connections. All DMX512 and Ethernet network components shall be compatible with the following ANSI Standards:
    a. ANSI E1.11 - Entertainment Technology USITT DMX512-A - Asynchronous Serial Digital Data Transmission Standard For Controlling Lighting Equipment and Accessories.
    b. ANSI E1.20 - Entertainment Technology RDM - Remote Device Management Over DMX512 Networks
    c. ANSI E1.31 - Entertainment Technology - Lightweight Streaming Protocol For Transport of DMX512 using ACN.
2. Provide all control wiring and control cables for a complete functioning system so that all control and dimming components, except portable lighting fixtures, can be interconnected and tested at the time of system commissioning.

B. CONTROL EQUIPMENT RACKS (CER-1 & CER-2)
1. Provide floor or wall-mounted control equipment rack(s) for housing selected components described in this section and as noted in contract drawings.
2. Control equipment rack shall be a 16-gauge steel wall-mounted enclosure with provisions for a locking front door. The front door shall be solid or with a plexiglas insert per drawings. Doors shall be easily removable in the field. Plexiglas doors shall be reversible to hinge on the left or right side in the field. The side and rear panels shall contain louvered vents. Provide 5 sets of keys to the owner. When multiple racks are indicated they shall be keyed alike.
    a. CER-2 rack containing the SMP control station shall be Middle Atlantic SWR-series shallow wall rack with PFD-xx door.

3. The rack shall contain 2 pair (front and rear) of 11 gauge CRS mounting rails predrilled for #10-32 screws on standard EIA 19" spacing. Both sets of rails shall be adjustable from front to back. Provide screws sufficient to fasten all devices mounted in rack including blank cover plates and vent panels. Rear rails on CER-1 only.
4. All devices within rack shall be powered via UPS mounted in rack (CER-1 only). Provide additional power strips, as necessary, connected to UPS and designed to securely mount inside rear rails of rack.
5. Control equipment racks located in the stage areas or areas in or adjacent to the auditorium, seating area or control rooms shall only utilize a UPS power source if there are system control devices in the rack requiring 120VAC power. In this case the UPS shall be passively cooled with no fan noise or power shall come from a remote power source.
6. The rack shall be designed for single-phase 2-wire with ground operation at a maximum of 20 amps, 120 volts 60 Hz AC.
7. The rack shall be designed to allow for easy insertion and removal of all components, and for convenient access to all rear-mounted power and control connections.
8. The rack shall contain a minimum of 3 open rack spaces to accommodate future control devices. Provide solid blank panels for all empty spaces.
9. Provide labels on all devices in equipment rack if necessary to define function or clarify where control signals are fed from. Devices requiring labels include Ethernet nodes, DMX repeaters, and others as indicated on project drawings.
10. Items contained in the control equipment rack(s) shall include but are not limited to:
    a. Ethernet switch(es).
    b. CAT-5 cable management panel(s).
    c. Ethernet patch panel(s).
    d. Ethernet port label panel(s).
    e. DMX512/Ethernet nodes as required.
    f. DMX-to-0-10V interfaces as required.
    g. Sliding shelf & storage drawers.
    h. Stage Mangers Panel.
    i. A digital clock and timer panel.
    j. Adjustable panel mounted 12” LED gooseneck worklites with rotary dimmer knob (Littlite #RL-10-D-LED or equal).
    k. (1) UPS device.
    l. (lot) blank or vent panels as required.
    m. Architectural Lighting Control System Processor (see below.)

C. CONTROL RECEPTACLE STATIONS AND JUNCTION BOXES (CRS)
1. Control receptacle stations shall contain locking data-grade connectors and be provided with appropriately sized surface-mounted electrical back boxes unless noted otherwise. The faceplates shall have engraved nomenclature filled with contracting paint color for all connections. Ethernet connectors shall be Neutrik EtherCon RJ-45. Provide control receptacle stations with receptacles as indicated on Theatre Systems Consultant’s drawings.
2. All connectors shall utilize screw terminal or punchdown connections for termination of installed wiring, field soldering of connections is not acceptable.

3. Provide labels with unique port ID numbers corresponding to patch panel for every Ethernet network receptacle in the system.
    a. Provide a master list of all network segments with location, port #, measured cable length, and maximum extension cable length based on a 330 foot maximum network segment length. Master list shall be an engraved or silk screened on plastic or metal panel with white characters on a black background. Attach master list to equipment rack or adjacent wall next to each rack with network patch panels. Attach with screws, bolts, or concrete anchors. Adhesive only fastening is not acceptable.

D. ETHERNET SWITCH(ES)
1. Provide high-speed multiport Ethernet switch(es) suitable for use with the stage lighting control console and related ethernet nodes.
    a. Ethernet switch(es) shall contain a minimum of 24 ports. All connectors shall be located on the front of the unit.
    b. The switch shall have, located on the front panel, indicator status lights for each port as well as for general network and hub status.
    c. Switch(es) shall be mounted in equipment rack ‘CER-1’. Rack-mounting ears shall be provided.
    d. Ethernet switch(es) shall provide Power-over-Ethernet, PoE, based on the IEEE 802.3af standard.
    e. Provide a quantity of Ethernet switches as required, sufficient to support system design as indicated on contract drawings.

E. ETHERNET PATCH PANEL
1. Provide Ethernet patch panel(s) for terminating Category-5 ethernet wiring from field devices.
2. The patch panel(s) shall contain a quantity of ports sufficient to connect all field wiring devices. Minimum of 12 ports per patch panel. If all slots in patch panel are not required provide (5) spare, un-used RJ45 panel mount connectors for future expansion.
3. Patch panel(s) shall be mounted in equipment rack ‘CER-1’.
4. Provide separate 1RU blank panel(s) for labeling patch panel ports. Label each port with a unique I.D. label indicating port # and location for all Ethernet jacks connected to field wiring devices.
5. Provide a sufficient quantity of CAT-5 patch cables to connect all field wiring devices to Ethernet switch(es) plus (5) spare cables.
6. Provide red patch cables for all devices that are to remain permanently connected for basic system functionality including dimmer, racks, architectural control processor, hard wired LCD stations, and installed Ethernet nodes.
7. Provide rack-mounted cable management panel(s) for dressing of patch cables between patch panel and Ethernet switch(es).

F. UNINTERRUPTIBLE POWER SUPPLY (UPS)
1. Provide (1) rack-mounted uninterruptible power supply (UPS) for use with the control data network devices located within the control equipment rack “CER-1”. The UPS shall be sized to power all equipment installed in the rack with an allowance for future equipment but shall not be rated for less than 450 watts.

G. DMX512-to-0-10V INTERFACE

1. Provide DMX512-to-0-10 volt interface for control of 0-10V lighting fixtures.
2. Interface shall contain (24) analog outputs and, DMX512 input and pass thru connection with selectable end-of-line termination switch, and a network connection port.
3. Interface shall be suitable for DIN rail mounting and shall include an associated 120VAC power supply. Provide complete assembly in a rack tray suitable for mounting in a 19" equipment rack.
4. Converter shall be RDM discoverable and configurable.
5. All connections shall be via pluggable screw terminals.
6. Interface shall be selectable for 0-10, 0-15, 0-2.5, & 0-5V output modes. Current sinking output shall be possible. Interface shall support 10mA current source per channel and 30mA current sink per channel.

H. ETHERNET NODES
   1. PORTABLE DMX512-TO-ETHERNET NODES
      a. Provide portable DMX512 Ethernet pipe-mount nodes for connection to the stage lighting control network. DMX512 Ethernet Nodes shall be provided with the following features:
         1) ANSI E1.11 (DMX512-A), E1.20 (RDM) and E1.31 (sACN) compatibility.
         2) LCD screen for displaying status and configuration information.
         3) (1) Neutrik EtherCon RJ-45 Ethernet receptacle.
         4) (2) DMX512 receptacles configured as Outputs or Inputs. Ports shall be fully configurable via software provided by the Manufacturer.
         5) Nodes shall be capable of PoE Power-over-Ethernet operation.
         6) Pipe Clamp, mounting hardware, and safety cable for attachment to lighting pipes or handle with mounting hardware for desktop or surface mount applications.
      b. Temporarily connect nodes at field locations to ensure functionality of node with system. Return portable nodes to owner after system checkout, acceptance, and training.
      c. Refer to schedule of quantities on project drawings for types and quantities of nodes.
   2. RACK MOUNTED DMX512-TO-ETHERNET NODES
      a. Provide rack-mounted DMX512-to-Ethernet nodes for distribution of control signals to/from field devices as shown on Theatre Consultant's drawings. Rack-mounted DMX512-to-Ethernet Nodes shall be provided with the following features:
         1) ANSI E1.11 (DMX512-A), E1.20 (RDM) and E1.31 (sACN) compatibility.
         2) LCD screen for displaying status and configuration information.
         3) RJ-45 Ethernet receptacle on rear of unit or integral to circuit board.
         4) (2) DMX512 receptacles per node configured as outputs or inputs. Ports shall be fully configurable via software provided by the Manufacturer.
         5) Nodes shall be capable of PoE Power-over-Ethernet operation.
   3. PANEL MOUNTED DMX512-TO-ETHERNET NODES
      a. Provide panel mounted one-port, DMX512-to-Ethernet nodes, user configurable as an input or output, as shown on Theatre Consultant's drawings.

b. Node shall be capable of PoE operation, shall fit in a standard single gang deep backbox, and shall mount with standard Decora-style faceplates.
c. Node shall utilize an XLR5 male or female connector and shall contain signal indicators for Network and DMX512 status.
d. Node shall support multiple protocols including E1.31 Streaming ACN [sACN/Net3], ArtNet, Pathport Protocol, ETC Net3, Vari-Lite ShowNet.

4. PORTABLE VIDEO ETHERNET NODE
   a. Provide (1) portable table-top Video Ethernet Node for remote video connection to the main lighting control console. Remote video node shall be provided with the following:
      1) (1) UTP 10Base-T Ethernet port.
      2) Ports for connection of (2) Video Monitors. Video ports shall be configurable via software provided by the Manufacturer.
      3) Ports for connection of (1) Keyboard, and (1) mouse.
      4) LED indicator for display of power and network activity.
      5) (1) Full-size PC Keyboard and mouse.
      6) 24” LCD flat-panel touchscreen display monitor(s).
   b. If the Stage Lighting Manufacturer’s lighting console only supports a wireless video node in the form of a laptop computer, then the following accessories shall also be supplied:
      1) A quantity of Wireless access points and mounting hardware required to provide a strong signal to the computer at any location in the auditorium, backstage, and control room areas.
      2) (1) laptop computer with a minimum 15” display and included wireless card or built-in wireless capability.
      3) A lockable hard carrying case with space for computer, power supplies, cables, and accessories. Carrying case to include permanently attached label: ‘VIDEO NODE.’
      4) The laptop computer video node shall support an external video display. (1) external 22” LCD monitor shall be provided in addition to the LCD integral to laptop computer.
      5) Any additional accessories or items required to provide a complete and operational remote video node shall also be supplied. All original manuals and software (on CD-ROM or DVD) supplied with computer shall also be provided.

I. STAGE LIGHTING CONTROL CONSOLES
   1. Provide (1) stage lighting control console “CC-1”. The control console shall support the following minimum requirements:
      a. 2,048 DMX512 channels via XLR5 outputs. 12,288 DMX512 channels via lighting network (optional). Provide with 2,048 Control channels.
      b. 1,000 cues, 1,000 groups, 1,000 Macros. 400 effects.
      c. 1000 Palette presets for each of 4 moving light attribute groups
      d. 1 master playback fader with support for additional virtual playback faders with fully independent cuelists. Tracking and cue-only operation.
      e. 20 Submasters (minimum).
      f. Connections for (2) external video touchscreen displays.
      g. 4 rotary encoders for control of automated lighting functions.
      h. Attribute library support for automated lights.

i. Onboard editing function to allow user to add new fixtures to the attribute library.
j. Color picker function for color-changing lights.
k. Data storage via 40GB internal hard drive or via USB flash drive.
l. Automated lighting control support. Attribute library support for automated lights including an onboard editing function to allow user to add new fixtures to the attribute library.
m. Wireless Remote Focus Unit (WRFU) support via lighting network.
n. Offline editing software for creation and editing of control console show files.
o. Console facepanel and processor shall be a single integrated unit.
p. Basis of Design Products
    1) Electronic Theatre Controls, Ion Xe20, 2048 output.
    2) Vari-Lite Lighting, Neo, 2,000 Channel, with fader wing utilizing 20 submasters.

2. Provide 21” LCD flat panel video display monitor(s) with touchscreen capabilities and dust covers for use with “CC-1”.
3. Provide all related cables and accessories needed for a complete operating system that integrates the new stage lighting control and dimming system. All cables to be constructed from high quality data cable suitable for repeated flexing and portable operation, ProPlex or equal. These cables and accessories include but are not limited to:
    a. (1) 15' CAT-5 data cable with RJ-45 connectors.
    b. (1) 15’ DMX512 data cable with XLR5 connectors.
    c. (2) Console 18” gooseneck dimmable ‘Littlite’ or equal dimmable LED worklights for “CC-1”. Lights shall either securely attach directly to console via an XLR or BNC-style connector or if detached Littlites they shall include a weighted base suitable for tabletop use.
        1) Detached dimmable Littlites shall be model #MV-18-LED with #CWB cast weighted base.
    d. Control console dust cover.
    e. (1) Keyboard and (1) mouse for each control console.
    f. (2) 8GB USB flash drives for storing show and system information.
4. Provide (1) uninterruptible power supply (UPS) for use with the stage lighting control console “CC-1”. The UPS shall be sized to power the control console and (2) LCD monitors. The UPS shall be suitable for floor or desk-top mounting. UPS shall be passively cooled, no fans or other noise generating devices shall be included.
5. Provide all related cables and accessories needed for a complete operating system that integrates the new stage lighting control and dimming system. All cables to be constructed from high quality data cable suitable for repeated flexing and portable operation, ProPlex or equal. These cables and accessories include but are not limited to:
    a. (1) 15' CAT-5 data cable with RJ-45 connectors.
    b. (3) 15’ DMX512 data cable with XLR5 connectors.
    c. (2) Console 18” gooseneck dimmable ‘Littlite’ or equal dimmable LED worklights for “CC-1”. Lights shall either securely attach directly to console via an XLR or BNC-style connector or if detached Littlites they shall include a weighted base suitable for tabletop use.

1) Detached dimmable Littlites shall be model #MV-18-LED with #CWB cast weighted base.

d. Control console dust cover.
e. (1) Keyboard and (1) mouse for each control console.
f. (2) 8GB USB flash drives for storing show and system information.

J. WIRELESS REMOTE FOCUS UNIT

1. The WRFU shall be a portable hand held touchscreen device for remote connection to the primary control console. Software for use on device shall be provided and installed prior to system checkout and training. Device shall utilize an 8 inch capacitive multi-touch display and shall be mounted in a rugged enclosure. Remote focus unit capabilities shall include:
   a. Console programming functions including playback, parking, and patching of channels.
   b. Direct selects and playback controls.
   c. Color picker for selected fixtures.
   d. Rechargeable battery.
2. WRFU should be supplied with the following:
   a. Hand strap
   b. Charging cable/adapter
   c. USB Hub
   d. Office docking cradle with stand
   e. EETi Stylus Pen
3. Provide a wireless access point (WAP) that is PoE powered for use in providing wireless connectivity between control console and Android or iOS devices (tablets and phones) as well as wireless remote focus unit noted above.
4. If manufacturer's wireless remote utilizes a proprietary wireless base station provide an additional WiFi base station that is PoE powered for use in providing wireless connectivity between control console and Android or iOS devices (tablets and phones).

2.04 ARCHITECTURAL LIGHTING CONTROL SYSTEM

A. The Architectural Lighting Control System shall control the following components and functions:

1. Houselighting Control for dimming of the permanently installed house light fixtures located in the auditorium.
2. Worklighting Control for switching of all permanently installed worklight fixtures located backstage, in the box boom and front catwalk areas.
3. Rehearsal Lighting Control for dimming of all portable lighting fixtures mounted in the FOH catwalk and on the stage lighting electric battens over the stage.
4. Running Light Control for dimming of permanently installed performance run light fixtures in the backstage stage area and for receptacles for portable run light circuits as indicated on project drawings.
5. Stage Preset Lighting Control shall provide the capability to record and playback scenes that have been created with the stage lighting control console. Playback of scenes shall be possible without the aid of the control console.

B. The Architectural Lighting Control System shall not utilize control stations that are addressed using rotary encoders, DIP switches or other physical means at the individual station.

C. Provide station power modules or repeater modules in sufficient quantities to support the number of control stations and layout as shown on project drawings.

D. The Architectural Lighting Control System shall support the following system functionality:
   1. System shall support creation and scheduling of real time events via a network connected PC with a web browser. Real time events shall also be able to be created, modified, and monitored from LCD stations connected via the Stage Lighting Ethernet network.
   2. Houselight presets and stage presets shall have user-configurable fade times adjusted from a single page on any of the LCD stations via a password protected setup page. House or stage presets shall operate with the same fade time regardless of where they are recalled from, this includes multiple LCD pages, hard buttons on the SMP, or hard buttons on the PCS devices.
   3. Run light circuits shall include the capability to set a maximum level via a level fader on a password protected setup page. Run light circuits can then be toggled on and off via a single button per circuit without the level exceeding the maximum set on the fader.
   4. Logic shall be incorporated to manage power supply circuits for DMX512-controlled houselights. Features shall include:
      a. Power supply circuits shall be turned on if any DMX control channel is above 0%.
      b. Power supply circuits shall automatically turn off after a pre-determined time if no houselight DMX control channels are above 0%.
   5. The portable control stations (PCS-x) shall reflect the current state of circuits and presets in the system when re-connected to system receptacles.
   6. The system shall support the ability to separately lockout remote houselight stations (HCS-x) and remote worklights control stations (WCS-x) from any LCD screens in the system. When remote stations are locked out they shall exhibit behavior to indicate they are in a different state. Indications could include the button changing color or button illumination blinking several times.
   7. The system shall support group functionality of circuits such that a single button on a station or page of LCD station shall be able to control circuits that are individually switchable via other stations or LCD pages. The group button shall then be able to reflect a mixed state when all circuits within the group are not in the same state by changing the button illumination to another color (amber).
   8. The system shall allow any button, fader, or object on an LCD page for physical station to be in any space or room within the system configuration. Any button or object shall also be able to be excluded from room/space all off or global all off commands.
   9. The system configuration software shall have the ability to create full pages of multi-line text with system information and operating instructions.

E. STAGE MANAGER’S CONTROL PANEL (SMP-1)

1. Provide an integrated Stage Manager's Panel "SMP-1" that consists of separate control sections for Houselights, Worklights, Rehearsal Lights, Run Lights, and Stage Preset pushbuttons. The panel shall be a dedicated enclosure and shall contain physical faders & buttons as well as a 7" color LCD touchscreen display.
2. The Stage Manager's Panel shall provide the following capabilities and requirements for the facility:
   a. Houselight Control: Houselight area controls via physical zone fader controls and a master fader, take-control, preset record, and lockout functions for houselight circuits.
   b. Worklight Control: Control of non-dimmable worklights, lockout, and all-off functions for worklight circuits via pushbutton controls with LED indicators.
   c. Rehearsal Light Control: Control of the rehearsal light circuits, all-off functions for rehearsal light circuits via pushbutton controls with LED indicators.
   d. Run Lights: Control of hardwired or portable run light circuits via pushbuttons.
   e. Stage Preset Control: Recording and playback of stage lighting via user recordable DMX snapshots. Stage Presets shall be snapshots assigned to pushbuttons.
3. The LCD touchscreen display shall mimic all functions available as physical faders and buttons on the "SMP-1" panel. The LCD shall also provide for additional functionality not available with physical controls including monitoring of real time events created in the architectural control system. Programming of LCD pages shall be submitted and reviewed with Theatre Systems Consultant 4 weeks prior to system commissioning.
4. Provide instructions for recording Houselight & Stage presets as well as general operation of architectural lighting control system. Instructions shall be provided as user selectable help screens on the 7" LCD touchscreen.
5. The Stage Managers Panel "SMP-1" shall be constructed as a shallow rack panel for mounting in control equipment rack "CER-2". All individual sections of the SMP shall fit within a single custom rack panel that is no larger than 1 rack unit in size than indicated on project drawings. All individual stations, except the LCD panel, shall mount to a custom punched panel with electronics attached to the rear side of the panel so as not to necessitate the use of bezels on individual components.

F. PORTABLE CONTROL STATION (PCS-1)
1. Provide portable, table-top mount control consolettes with control capabilities and features similar to those of the Stage Manager's Control Panel (SMP-1). See above section STAGE MANAGER'S CONTROL PANEL (SMP-1).
2. The 'PCS-1' consolette shall be a tabletop LCD station with a 7" color touchscreen control panel which replicates all control functions present at 'SMP-1'. Buttons presses and control logic between stations shall mimic each other at the two stations. 'PCS-1' shall be a low profile station with a sturdy base and an angled face measuring not less than 30-degrees from horizontal for legibility of the LCD screen when seated at the control room counter or similar table.
3. The 'PCS-1' consolette shall connect to the architectural control system via Ethernet wiring

4. Provide 'PCS' station with (1) 15' and (1) 50' portable control cable with positive lock quick disconnect multipin connectors at each end for connection to control receptacle stations as indicated on project drawings and in project specifications.

G. HOUSELIGHT CONTROL STATIONS (HCS)
1. Provide prewired house pushbutton stations with appropriately sized back boxes to control the house lights. 1 momentary contact pushbutton with LED indicator light shall be provided to take control and turn on and off the house lights to a preset intensity level (cleanup preset). The control stations shall be suitable for flush mounting in custom electrical back boxes and shall include smoked Plexiglas hinged covers with magnetic twist latches. The faceplates shall be engraved with appropriate identification.

H. WORKLIGHT CONTROL STATIONS (WCS)
1. Provide prewired worklight pushbutton stations with appropriately sized back boxes to control the stage worklights. 1 momentary contact pushbutton with an LED indicator light shall be provided for each control circuit to turn on and off the work or rehearsal light circuits. The faceplate shall be engraved with appropriate identification. The stations and labels are indicated on the project drawings. Stations shall have smoked Plexiglas hinged covers with magnetic twist latches where indicated on project drawings.

I. CONTROL PROCESSOR FOR ARCHITECTURAL LIGHTING SYSTEM
1. The control processor for the Architectural Lighting System shall be mounted in the control equipment rack (CER-1). The control processor shall be designed for single phase 2 wire with ground operation at a maximum of 20 amps, 120 volts 60 Hz AC. The control processor shall have the following characteristics and requirements:
2. Interface electronics for controlling all house light dimmers, worklight nondims, rehearsal light nondims, and the stage presets control system shall be mounted in the control equipment rack
3. The control processing device shall have a control module with a multi-character display and keypad for system configuration. The control module shall have a memory card slot for storing the system configuration.
4. All control connections shall be terminated via factory provided plug-in connectors.

2.05 STAGE LIGHTING FIXTURES

A. Provide stage lighting instruments as indicated on the schedule of quantities on project drawings.

B. All stage lighting instruments shall be provided with the following accessories:
1. Pipe-mounting C-clamp (except followspots and floor-mounted instruments) and hanger brackets if yoke is not integral to instrument.
2. Floor trunions for floor mounted fixtures.
3. Color filter frame and 30" wire-rope safety cable with snap link closure.

C. Provide full-color LED profile spotlights suitable for long throw applications [production spotlights]. Fixtures shall include the following:

1. Die cast all metal housing with shutter barrel, double clutch locking yoke. Shutter barrel shall contain accessory slots for use with templates (glass or steel), iris, or special effect devices. Provide with a black finish.
2. Full color LED light engine that utilizes one of the following LED arrays:
   a. RGBIL: Red-Green-Blue-Indigo-Lime
   b. RGBALC: Red-Green-Blue-Amber-Lime-Cyan
   c. RGBL: Red-Green-Blue -Lime
3. Built-in power supply with input voltage range of 100-240VAC, on-board processor, (60) Luxeon LED emitters with a minimum 50,000 hour L70 lamp life. Greater than 8,000 output lumens.
   a. Theatrical grade dimming with a 15-bit virtual dimming. Low noise cooling via a variable speed, temperature controlled or user controllable fan.
4. Power in and thru via powerCON TRUE1 or powerCON connectors. Power leads shall use a 5’ long powerCON-to-5-15P connector. DMX512 input and through connectors via 5-pin XLR connectors.
5. Enhanced definition lens tubes and/or barrel assemblies of various beam widths or zoom ranges per schedule of quantities on project drawings. Lens tube or barrel shall include accessory slots with locking capability for two accessories (gel frames, top hats, etc.). A soft focus diffuser shall be provided for each fixture for use in shutter barrel accessory slot.
6. Acceptable products:
   a. E.T.C. ColorSource Spot V
   b. Vari-Lite Leko LED
   c. Altman Phoenix PHX3.5
   d. Others contingent on pre-approval.

D. Provide full-color LED wash lights with variable zoom suitable for long throw applications [production wash lights]. Fixtures shall include the following:
   1. Die cast all metal housing, double clutch locking yoke. Fixture body shall contain accessory slots with locking capability for two accessories (gel frames, top hats, etc). Provide with a black finish.
   2. Full color LED light engine that utilizes one of the following LED arrays:
      a. RGBIL: Red-Green-Blue-Indigo-Lime
      b. RGBW: Red-Green-Blue-White
      c. RGBL: Red-Green-Blue -Lime
   3. Built-in power supply with input voltage range of 100-240VAC, on-board processor, (44) LumiLED Luxeon LED emitters with a minimum 50,000 hour L70 lamp life. Greater than 5,000 output lumens. Theatrical grade dimming with a 15-bit virtual dimming. Low noise cooling via a variable speed, temperature controlled or user controllable fan settings.
   4. Power in and thru via powerCON TRUE1 connectors. Power leads shall use a 5’ long powerCON-to-5-15P connector. DMX512 input and through connectors via 5-pin XLR connectors.
   5. Optical system shall utilize a motorized zoom with a range of 15-to-40 degrees minimum.
   6. Acceptable product:
      a. E.T.C. ColorSource Fresnel V
      b. Vari-Lite VL800 ProPAR
      c. Altman Lighting Hydra PAR AIP200
      d. Others contingent on pre-approval.

E. Provide full-color LED multi-cell asymmetric cyc lights. Fixtures shall include the following:
   1. Corrosion resistant metal housing, mounting yoke, adjustable rubber feet for floor mounting. Provide with a black finish.
   2. Full color LED light engine that utilizes one of the following LED arrays:
      a. RGBA: Red-Green-Blue-Amber
      b. RGBALC: Red-Green-Blue-Amber-Lime-Cyan
   3. Built-in power supply with input voltage range of 100-240VAC, on-board processor, LED emitters with a minimum 50,000 hour L70 lamp life. Greater than 7,500 output lumens. Theatrical grade dimming with a 15-bit virtual dimming. Fixture shall be passively cooled without the use of fans.
   4. Power in and thru via powerCON or powerCON TRUE1 connectors. Power leads shall use a 5’ long powerCON (or TRUE1)-to-5-15P connector. DMX512 input and through connectors via 5-pin XLR connectors.
   5. Fixture shall utilize an asymmetrical reflector for producing a smooth even wash from top-to-bottom of vertical backdrop.
   6. Acceptable product:
      a. Altman Spectra Cyc 200 RGBA
      b. Vari-Lite CODA LED Cyc
      c. Others contingent on pre-approval by Theatre Consultant.

F. Provide warm-white LED wide flood work lights suitable for long throw worklight applications [stage overhead rehearsal lights or stage wing work lights]. Fixtures shall include the following:
   1. Corrosion resistant metal housing, mounting yoke. Fixture body shall contain an accessory slot with locking capability for an accessory such as a gel frames, diffuser, or barndoor. Provide with a black finish.
   2. Built-in power supply with input voltage range of 100-277VAC, on-board processor, LED emitter with a minimum 40,000 hour L70 lamp life. Greater than 10,000 output lumens. The fixtures shall have a CCT of 3,000 kelvin and a minimum CRI of 90. The fixture shall be passively cooled without the use of fans.
      a. LED light engine shall be dimmable via phase cut 2-wire dimming or via on-board local fader control.
   3. Power in and thru via powerCON connectors. Power leads shall use a 5’ long powerCON-to-L5-20P grounded twistlock connector.
   4. Fixture shall include a diffused lens in frame.
   5. Acceptable products:
      a. Altman Lighting Worklight II (#WL-90).
      b. Others contingent on pre-approval by Theatre Consultant.

G. Provide warm-white LED wide flood work lights suitable for long throw worklight applications [stage overhead rehearsal lights or stage wing work lights]. Fixtures shall include the following:
   1. Corrosion resistant metal housing, mounting yoke. Fixture body shall contain an accessory slot with locking capability for an accessory such as a gel frames, diffuser, or barndoor. Provide with a black finish.
   2. Built-in power supply with input voltage range of 100-277VAC, on-board processor, LED emitter with a minimum 40,000 hour L70 lamp life. Greater than 10,000 output lumens. The fixtures shall have a CCT of 3,000 kelvin and a minimum CRI of 90. The fixture shall be passively cooled without the use of fans.

a. LED light engine shall be dimmable via phase cut 2-wire dimming or via on-board local fader control.

3. Power in and thru via powerCON connectors. Power leads shall use a 5' long powerCON-to-L5-20P grounded twistlock connector.
4. Fixture shall include a diffused lens in frame.
5. Acceptable products:
   a. Altman Lighting Worklight II (#WL-90).
   b. Others contingent on pre-approval by Theatre Consultant.

H. Provide warm white LED fresnel/PAR-style wash light for long throw worklight applications [FOH Rehearsal lights]. Fixtures shall include the following:
1. Corrosion resistant metal housing or die cast aluminum, mounting yoke. Provide with a black finish.
2. Built-in power supply with input voltage of120VAC, on-board processor, LED emitter with a minimum 45,000 hour L70 lamp life. Greater than 10,000 output lumens. The fixtures shall have a CCT of 3,000 kelvin and a minimum CRI of 90. The fixture shall be cooled with low noise temperature-controlled cooling fans
   a. LED light engine shall be dimmable via phase cut 2-wire dimming or via DMX512 control. Fixture shall include DMX512 input and output data connections via XLR 5-pin connectors or via adaptor cables for precise control of dimming if desired.
   b. Fixture shall be capable of on/off control via line voltage relay switching without the need for a separate data connection. The fixture shall turn on and output light in less than 1 second from application of power.
3. Power in and thru via powerCON TRUE1 or powerCON connectors. Power leads shall use a 5' long powerCON-to-L5-20P grounded twistlock connector. DMX512 input and through connectors via 5-pin XLR connectors
4. Fixture shall have an adjustable beamspread from 15 to 85 degrees via a zoom mechanism, from 10-to-30 degree via manual stops or shall vary beamspread via interchangeable lenses.
5. Acceptable products:
   a. Electronic Theatre Controls: Source 4WRD PAR, Gallery Edition, with MFL and WFL lenses
   b. Vari-Lite VL800 EventPAR WW
   c. Altman Pegasus8 LED Fresnel
   d. Other contingent on pre-approval by Theatre Consultant.

I. Provide full-color LED PAR-style wash lights with variable beam [stage wing run lights]. Fixtures shall include the following:
1. Die cast all metal housing, mounting yoke, accessory slots with locking capability for two accessories. Provide with a black finish.
2. Full color LED light engine that utilizes one of the following LED arrays:
   a. RGIL: Red-Green-Indigo-Lime
   b. RGBA: Red-Green-Blue-Amber
3. Built-in power supply with input voltage range 100-240VAC, on-board processor, (40) Luxeon LED emitters with a minimum 50,000 hour L70 lamp life.
4. Theatrical grade dimming with a 15-bit virtual dimming. Low noise cooling via a variable speed, temperature controlled or user controllable fan settings.

5. Power in and thru via powerCON or powerCON TRUE1 connectors. Power leads shall use a 5' long powerCON-to-5-15P connector. DMX512 input and through connectors via 5-pin XLR connectors.
6. Beam shall be varied via interchangeable lenses or and adjustable a multi-stop lens assembly with beam angles of 10-30 degrees.
7. Acceptable product:
   a. E.T.C. ColorSource PAR (Deep Blue) with (1) narrow and (1) medium oblong lens per fixture.
   b. Vari-Lite VL800 EventPAR RGBA
   c. Others contingent on pre-approval.

J. Provide 600 Watt LED 120V Followspots. Fixtures shall include the following:
1. Followspots to include integral power supply, 10' cable with Edison receptacle, and illuminated on/off rocker switch. Other features include:
   a. 7 deg to 14.5 deg zoom
   b. 6-way self-cancelling color boomerang
   c. A-size gobo holder
   d. Fully-closing iris cassette
   e. Chopper kit
   f. Stainless steel trim shutters
   g. Telescoping floor stand with casters and leveling jacks
2. Acceptable products:
   a. Robert Juliat OZ 1169TC
   b. Lycian Stage Lighting #1280
   c. Strong iChip 600 LT
   d. Others contingent on pre-approval.

K. Provide a ghostlight fixture consisting of a 72" tall base and stand assembly with a medium screw base socket enclosed with a protective basket. Base to include 3 locking casters. Fixture shall include 15' of 12/3 type SJ power cord with a 5-15P parallel blade+ground connector installed. .
1. Supply with (1) medium screw base LED lamp, A-21 size, approximately 20 watts, Phillips #451906 or equal.
2. Basis of design: Altman Ghost-Light

L. STAGE LIGHTING FIXTURES EQUIPMENT LIST:
1. Stage lighting fixture quantities per schedules on project drawings.

2.06 STAGE LIGHTING ACCESSORIES

A. Provide stage lighting cable and accessories as indicated on the schedule of equipment quantities on project drawings. Cables shall be fabricated per the following criteria and per details on project drawings.
1. All extension cables shall be marked near each end for length identification per details on project drawings. Labels shall be covered with clear, shrink-wrap tubing. Utilize 3/4" wide Scotch 35 Color Coding Vinyl Electrical Tape for coloring. Length color code is as follows:
   a. 6' = Yellow
   b. 10' = Red
   c. 15' = (1) Yellow + (1) Red w/ 3/4" gap in-between

d. 20’ = (2) Red w/ 3/4” gap in-between
e. 25’ = Orange
f. 50’ = Brown
g. 75’ = (1) Brown + (1) Orange w/ 3/4” gap in-between

2. All data extension and adaptor cables utilizing XLR 3,4,5 or 6-pin connectors shall utilize Neutrik XX-series connectors with gold plated contacts, black shell and colored bushings to identify cable function. Network extension cables shall utilize Neutrik Ethercon connectors. Bushing colors shall be as follows:
   a. Network - XLR Ethercon = Blue
   b. DMX512 - XLR 5-pin = Violet
   c. DMX512 - XLR 3-pin = Gray
   d. Power/Data - XLR 4-pin = Green
3. DMX data cables and power supply/data cables shall be terminated with heat shrink tubing over the drain wire and clear heat shrink tubing over the portion of cable where the outer jacket has been stripped from individual conductors.
4. Provide and install a tie-line with each extension cable for securing cables when coiled. Tie-line shall be 1/8” black cotton trick line/tie-line, unglazed, attached to cables with clove hitch and half-hitch knots, minimum 36” long.
5. All extension, adaptor and miscellaneous cables shall be provided with a 3” long clear length of heat shrink tubing installed on cables for owner-provided labeling.

B. Extension cables
1. Provide CAT-5 Ethernet data portable extension cables with TMB ProPlex PCCAT5EP cable & Neutrik EtherCon RJ-45 connectors with black shells and colored bushing to identify cable function.
2. Provide portable DMX512 control extension cables constructed from TMB ProPlex PC224P cable with heavy-duty jacket and Neutrik 5-pin XLR connectors with gold plated contacts, black shells, and colored bushings to identify cable function.
3. Provide 12/3 type SO portable stage extension cables with male and female 20A 120V grounded stage pin connectors.
4. Provide 12/3 type SO portable stage extension cables with male and female grounded 5-15 Edison connectors.
5. Provide 12/3 type SO portable stage extension cables with male and female grounded L5-20 connectors.
6. Provide Neutrik powerCON or powerCON TRUE1 jumper cables for daisy-chain of LED light fixtures.
   a. Final quantity of each style of extension cable will be determined during submittals depending on what connector type submitted fixtures use.
7. All extension cables shall be marked near each end per details on project drawings. Labels shall be covered with 3” long, clear, shrink-wrap tubing. Install tie-line with each extension cable for securing cables when coiled. Provide colored bushings for data cables to identify functions per detail drawings. All data connectors shall be either Neutrik X-series (Network) or Neutrik XX-series (DMX512 cables).

C. Adaptor & Miscellaneous Cables
1. Provide molded-rubber-cable twofers with 20 amp grounded Edison connectors. Lengths and quantities per schedules on project drawings.

2. Provide 20 amp 12/3 male grounded stage-pin to female grounded Edison adaptors.
3. Provide DMX5-pin turnaround cables, XLR5M-to-XLR5M.
4. Provide DMX terminating plug, XLR5M with 120 ohm resistor across pins 2 and 3.
5. Provide PowerCon couplers for connecting two PowerCon extension cables together. Neutrik #NAC3MM-1.
6. All DMX data adaptor cables shall be fabricated from either Neutrik X-series or Neutrik XX-series connectors with gold plated contacts, black shell and colored bushings to identify cable function per detail drawings. All cables shall be fabricated with the same Neutrik series connector.

D. Provide stage lighting tophats to fit 19°, 26°, 36°, 50° profile spotlights. Sizes and quantities per schedules on project drawings. Tophats shall have a safety cable permanently-affixed.
   1. 50° tophats to be sized to be compatible with lens tube.

E. Provide 4-pane stage lighting barndoors to fit PAR style run lights and LED washlights. Barndoors shall have a safety cable permanently-affixed.

F. Tophats, barndoors, and color extenders shall have a safety cable permanently-affixed via a galvanized aircraft cable attached to the device with a loop terminated with a nicopress sleeve and with a snap hook captured at the other end via a loop and nicopress sleeve.

G. Provide template holder for ellipsoidal reflector spotlights for A-size or M-size patterns.

H. Provide 3,000’ spool of 1/8” black unglazed tieline.

I. Provide road cases for storage of portable stage circuit extension cables, control cables, two-fers, adaptors, and accessories. Road cases shall have the following features:
   1. Case construction shall conform to A.T.A. standards, specification 300, category 1.
   2. Case shall be of the hinged-lid, rolling variety. Approximate outside dimensions of case shall be 40” long by 25” wide. The storage section shall be 24” high with an upper hinged lid section. With casters the overall height of the case shall be approximately 30”.
   3. Cases shall be constructed from ½” plywood with a fiberglass laminate exterior surface bonded to plywood. Line the inside of the case with outdoor carpet or provide another method for limiting splintering along the inside walls of the case. Laminate surface color: BLACK.

4. All fittings and edges shall be fabricated with tapered aluminum and shall be attached via split steel rivets every 3”. Aluminum tongue-in-groove fittings shall be used at the perimeters of the lid to ensure positive alignment. A continuous length steel piano hinge shall be utilized for the lid along with 2 nylon straps to limit lid travel. (2) recessed spring loaded latches shall be provided opposite hinged side along with (4) recessed spring loaded handles with foam grips at the ends of the case. Steel ball corners shall be provided at each corner of the case. Provide (4) heavy duty ball-bearing casters with a minimum load bearing capacity of 225 pounds each. Attach casters to bottom of case with reinforcing caster plates. Install (4) caster cups in lid of case for ease of stacking cases.
5. Provide a removable wooden partition perpendicular to the long side of the case at the case center. Provide guides for the partition to slide into and a rounded rectangular hole near the top of the partition for a hand hold. Partition to be constructed from 1/2” wooden material that is resistant to splintering.
6. Stencil with white paint the top and 4 sides of the case with the name of the owner or auditorium (verify with Architect prior to fabrication), a unique case # (#1 though 3 or similar) and the text “STAGE LIGHTING” in 1” high block letters.
7. Case manufacturer shall be equal to Jan-al “Rhino ATA” or equivalent contingent on approval of the Theatre Consultant. Quantity per schedule on project drawings.

2.07 ACCEPTABLE STAGE LIGHTING EQUIPMENT MANUFACTURERS

A. Acceptable stage lighting dimming and control manufacturers
1. Electronic Theatre Controls (ETC)
   3031 Pleasant View Rd
   Middleton, WI 53562
   800-688-4116
2. Vari-Lite Lighting
   10911 Petal Street
   Dallas, TX 75238
   214-647-8031

B. Acceptable stage lighting fixture manufacturers
1. Electronic Theatre Controls (ETC)
2. Vari-Lite Lighting
3. Altman Stage Lighting

C. Acceptable dimmer circuit distribution equipment manufacturers
1. Electronic Theatre Controls (ETC)
2. Vari-Lite Lighting
3. SSRC
4. Altman Stage Lighting

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor shall furnish and install a completely functioning dimming system. All equipment, fittings, and peripheral devices for correct system operation shall be quoted and supplied.

B. Installation shall be in conformance with local, state and N.E.C. codes specifications and in accord with manufacturer's recommendations.

C. All lighting instruments and items of equipment, and individual components where applicable standards have been established, shall be listed by Underwriter's Laboratories, Inc. and shall be the U/L or ETL label when delivered and installed on job.

D. All Ethernet cabling shall be category 5e UTP and shall conform to TIA-568B standard and shall be installed, terminated, and certified by The Systems Integrator.

E. No part of the system shall be energized before being checked and the installation approved.

F. Protection and cleaning:
1. Materials and Equipment: Cover all equipment stored or installed on the site with polyethylene sheets or approved equivalent, to protect equipment from dust, moisture, plaster, cement, paint or work of other trades.
2. Storage: Provide proper and adequate storage facilities.
3. Damage: Replace all damaged or defective work, materials, or equipment. Install sensitive or delicate equipment after major construction work is completed.
4. Site Cleaning: Regularly remove waste and rubbish and maintain order.
5. Equipment Finish: Clean and polish all surfaces.
6. Acceptance: Remove all debris, dirt, grease, and oil from building surfaces caused by installation work. Clean and vacuum all rooms in which installation work has occurred.

G. Installation Notes:
1. Each dimmer circuit requires a separate hot and separate neutral. NO COMMON NEUTRALS.
2. The theatrical stage lighting drawings are diagrammatic only. Do not scale the drawings to determine the location of equipment.
3. Do all drilling, cutting, channeling and patching required to install lighting equipment and electrical work as indicated or herein specified. All holes, curbs, etc. in floors, ceilings, and walls shall be patched, unless indicated otherwise. Paint all new exposed electrical raceways, cabinets, enclosures, and fittings to match in color adjacent surfaces in finished areas.
4. Seal all penetrations through fire rated walls, ceilings, floors, etc., to maintain the fire rating. Furnish and install fire rated enclosures for all equipment penetrating into fire rated envelopes, spaces, etc.
5. Location of all conduit runs and junction boxes must be approved by the Theatre Systems Consultant and Electrical Engineer prior to actual construction.

3.02 SYSTEMS INTEGRATOR INSTALLATION RESPONSIBILITIES

A. Systems integrator shall be responsible for the following:
   1. Verify mounting locations for all wiring devices with installing contactor.
   2. Verify all data cable types and wiring topologies with installing contractor based on system manufacturer requirements.
   3. Coordinate early release of backboxes or other equipment required for rough-in.
   4. Pre-configure and test all permanently installed intelligent architectural fixtures such as DMX-controlled fixtures that are connected to or controlled by the theatrical lighting systems.
   5. Make a minimum of 5 site visits prior to initial system commissioning to monitor jobsite progress and to coordinate with the installing contractor.
   6. Coordinate multi-cable and data cable installation supported by stage rigging with rigging contractor to ensure that cable is arranged per project drawings.
   7. Terminate all stage lighting data wiring connected to the stage lighting dimming and control equipment even if the Systems Integrator was not part of the chain-of-supply for select pieces of equipment (DMX or 0-10V controlled lighting fixtures).
   8. Test all Ethernet network segments and provide a detailed test report to Theatre Consulting.
      a. A report with individual test reports for all Ethernet cable segments shall be submitted to the consultant 5 days prior to commencement of the final punch list inspection. The report should be generated by a network analyzer similar to the Fluke DSP-4000 series
   9. As an authorized field service commissioning agent for the primary theatrical lighting equipment vendor, commission the entire theatrical lighting dimming and control system.
      a. Configure control data distribution system and architectural lighting control system with the following parameters:
         1) The control network and dimming system shall be configured so that architectural lighting circuits (work lights, rehearsal lights, running lights) are not controlled by the stage lighting console.
         2) The control network and dimming system shall be configured so that the stage preset pushbuttons can record all DMX addresses in universe #2 and all addresses in universe #1 except for the architectural lighting circuits.
         3) The programming of the architectural lighting touchscreen stations and all button and fader stations shall be configured and tested with offline software 4 weeks prior to the expected system commissioning date in conjunction with the Theatre Consultant.
            a) All pushbuttons at remote WCS and HCS stations shall utilize dim blue indicators when associated circuit(s) is off and bright green when on. All pushbuttons shall flash with a slow red indicator or use another scheme to indicate when a button is pressed that the station is locked out.
            b) Instructions for recording Houselight & Stage presets as well as general operation of architectural lighting control system. Instructions shall be provided as user selectable help screens on the 7” LCD touchscreen. Circuit #’s for architectural lighting circuits shall be listed along with help screens.

10. Verify that all manufactured items delivered to the project site are fabricated per approved submittal drawings prior to installation.
11. Coordinate receiving of portable theatrical equipment and prevent from loss or damage until time of installation or turnover.
12. Provide trained and highly qualified theatrical stage lighting technicians to properly hang and focus aim adjust the stage lighting spotlight fixtures. This installation shall consist of the following:
    a. Unpack light fixture, install lamp, bench focus fixture, install c-clamp, safety cable, and any related hardware or accessories, dispose of packing materials.
    b. Hang fixtures and connect to power circuit receptacles as noted on initial light plot. Install portable data cable for intelligent fixtures.
    c. Install any color filters noted on initial light plot in project drawings.
    d. For intelligent, programmable fixtures perform a complete setup including assigning DMX addresses and applying other profile settings as requested by Theatre System Consultant and as required to provide an integrated functioning system.
    e. Do not install fixtures until facility is reasonably dust free to prevent the accumulation of dust and dirt on lenses and reflectors. If facility is not dust free place plastic bags over fixtures and until time of checkout. Unplug fixtures to prevent accidental activation while fixtures are covered.
    f. Maintain an inventory of how many sheets of color have been used as well as any cable or accessories installed for the purpose of verifying inventory of system accessories at time of final checkout.
    g. Patch all lighting fixtures at control console and verify that entire light plot functions normally when controlled by primary control console and architectural control system. Verify that fixture profiles are installed for all intelligent fixtures provided as part of the project. Obtain missing profiles from the control console manufacturer or create full function profiles with a personality editor.
13. Provide training sessions to end-user as defined elsewhere in specification.
14. Deliver project closeout documents including O&M manuals for all theatrical lighting equipment as well as as-built submittal drawings. See additional requirements in project general conditions documents.

3.03 TESTING AND COMPLETION

A. Provide all instruments for testing and demonstrate in presence of the School's Representatives that all circuits and wiring tests free of shorts and grounds.

B. Furnish all labor, instruments, appliances, equipment, and materials necessary to demonstrate to the School that the installations perform as required and are as specified herein.

C. The School reserves the right to make independent tests of all equipment furnished to determine whether or not equipment complies with requirements specified herein and to accept or reject any or all equipment on basis of results thereby obtained.

D. Within 14 days of written request, the Systems Integrator shall provide a factory engineer to check installed systems and make any adjustments or modifications necessary for proper operation.

E. Should any follow-up checkout and inspection visits be required by the Architect, Electrical Engineer or Theatre Systems Consultant due to any installation caused matters after the approved completion of the project, the Contractor shall bear this cost at the Architect's, Engineer's and Consultant's standard hourly rates. This shall be scheduled and approved in writing.

3.04 TRAINING AND INSTRUCTION

A. The stage lighting equipment manufacturer and/or the Contractor shall provide operations and maintenance instruction to School personnel as follows:
   1. A minimum of two (2) and not to exceed four (4) hours of operations instruction for the School's faculty, staff, and students.
   2. A minimum of one (1) and not to exceed two (2) hours of maintenance instruction for the School District's maintenance staff

B. All training sessions shall be coordinated with the school schedule. Cost of such instructional services shall be part of the Contractor's bid.

C. Review of written operations and maintenance manuals and submittal drawings shall take place during these training sessions.

END OF SECTION

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes furnishing materials, equipment, labor, supervision, coordination, tools and items necessary for the construction, installation, connection, integration, testing and operation of communications systems work for this project.

1.02 RELATED WORK

A. General requirements specifically applicable to Division 27 in addition to the provisions of Division 1.

1.03 REFERENCES

A. The latest published edition of a reference shall be applicable to this Project unless otherwise noted.

B. International Building Code (IBC)

C. California Building Code (CBC).

D. Los Angeles City Building Code

E. American National Standards Institute (ANSI).

F. ANSI/TIA-568 - Commercial Building Telecommunications Cabling Standard.

G. ANSI/TIA-569 - Telecommunications Pathways and Space Standard

H. ANSI/TIA-606 - Administrative Standard for Commercial Telecommunications Infrastructure.

I. ANSI/TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises Standard.

J. ANSI/TIA-758 - Customer Owned Outside Plant Telecommunications Cabling Standard.

K. ANSI/TIA 1152 - Field Testing of Twisted Pair Communication Cables.

L. ANSI/TIA-4966 - Telecommunications Infrastructure Standard for Educational Facilities.

M. ANSI/TIA-5017 - Telecommunication Physical Network Security Standard.

N. ANSI/TIA-5071 - Field Testing Single Pair Cabling System.

O. ANSI/TIA TSB-184A – Guidelines for Supporting Power Delivery Over Balanced Twisted Pair Cabling.

P. ANSI/Building Industry Consulting Service International (BICSI) - Telecommunications Distribution Methods Manual (TDMM).

Q. ANSI/BICSI-N2-17 - Practices for the Installation of Telecommunication and ICT Cabling Intended to Support Remote Power Applications.

R. National Fire Protection Association (NFPA) Article 70, Article 72, Article 78.

S. National Electrical Code National (NEC).

T. National Electrical Safety Code (NESC).

U. Federal Communications Commission (FCC).

V. Underwriter's Laboratories (UL).

W. Local fire code, building code, mechanical code, electrical code, rules and interpretations required by the authority having jurisdiction (AHJ).

X. The referenced codes establish a minimum level of requirements. Follow the more stringent provision of the codes where there is a conflict between codes. Follow any code where there is a conflict between the code and the requirements of the Specifications. Compliance with code requirements shall not relieve the responsibility from complying with the requirements of the Specifications and the Drawings.

1.04 WORK OF OTHER TRADES

A. The Drawings do not show complete details of the building construction. Refer to the architectural, structural, civil, fire protection, mechanical, electrical, mill work and reflected ceiling Drawings for those details which may affect the execution of this Work.

B. Coordination: Conform to the requirements of Division 01. Failure to coordinate Work will be considered sufficient cause for Work to be altered at Contractor's expense, as directed by Architect.
   1. Plan and execute Work including, but not limited to conduits, back boxes enclosures and speakers in cooperation with other trades.
   2. Notify other trades of any Work affecting their Work to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeves,

firestopping, painting, finishing, or other matters which will cause delays or necessitate work-around methods.

C. Visit the site to verify demolition Work. Coordinate with the Owner prior to commencement of Work. Maintain service to existing equipment and devices to be retained in area adjacent to the areas scheduled for Work.

D. Protect the installation of and the integrity of existing systems, devices and cables during demolition Work.

E. Protect existing buildings and spaces from water and dust seepage into the existing buildings and spaces.

F. Protect, maintain and re-rate fire stopping system for floor and walls involved in the Work.

G. Utilities and Services:
   1. Do not disturb existing utilities without Owner's written consent. Notify the Owner and Architect not less than 10 days prior to the scheduled work date.
   2. Prior to demolition, field-verify and document existing area, conduits, ducts, utility vaults, and handholes shown for demolition.
   3. Where the area, ducts, conduits, manholes, and handholes contain utilities not shown for permanent demolition, submit a re-routing plan to the Architect showing the ducts, conduits, utility vaults, handholes, conductors, boxes, wiring, and connections required to re-route the utilities outside of the area affected by the

demolition. Upon receiving written approval of the re-routing plan, re-route existing utilities and systems in accordance with the approved work plan.

4. Prior to trenching and excavation, use a utility locator to locate existing underground utilities. Excavate to avoid underground utilities.
5. Prior to core drilling, use ground penetrating radar, pachometer, X-ray or other suitable means to locate existing rebar, embedded conduit, post tensioning cables and other imbedded obstructions. Locate core drill to avoid obstructions.
6. Where the Drawings show existing services to be abandoned, terminate in conformance with requirements of the utility and authority having jurisdiction.
7. Install and test new services prior to demolishing existing services unless otherwise shown.
8. Failure to verify the existing conditions or submit re-routing plan will be considered sufficient cause for work to be altered at Contractor's expense, as directed by Architect.

1.05 CODES, PERMITS, INSPECTIONS, AND FEES

A. Conform to requirements of Division 1 [Section [01 41 00]].

B. Obtain permits and inspections and pay fees required by National, State and Local authorities. Make arrangements for inspections by the Architect, Owner or other authority as required. Submit 3 copies of certificates of compliance to the Architect.

C. Work and materials shall be in accordance with requirements of the latest adopted edition of applicable codes, regulations, ordinances, and local amendments.

D. Remove Work that is not in compliance with the codes, ordinances, or regulations.

E. Where Drawings or Specifications call for material or construction of a better quality or larger sizes than larger sizes than required by the above-mentioned rules and

regulations, the provisions of the Drawings or Specification shall take precedence over requirements of the rules and regulations.

F. Coordinate with the appropriate “Authorities Having Jurisdiction” for this Project.
   1. Arrange plans and shop drawing reviews.
   2. Schedule inspections.
   3. Notify the Architect of non-conformance issues.
   4. Proceed with changes suggested by the authorities having jurisdiction only with written authorization by the Architect.
   5. Make necessary corrections as required by the authorities having jurisdiction.

G. Comply with rules and requirements of telecommunication service providers.

1.06 SAFETY

A. Coordinate job site safety requirements with the Architect and Owner. Provide safety measures continuously during work.

B. Provide safety policies, training, retraining, equipment, safeguards, restraints, permit systems, and other safety measures required by federal, state, local, and the Owner’s site rules and regulations and for the safe performance of the Work.

C. Comply with the “Safety and Health Regulations for Construction,” 29 CFR 1926, by the U.S. Department of Labor.

D. Consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether the Contractor is or is not in compliance with state or federal regulations.

E. Notify the Architect and Owner of any unsafe conditions observed or experienced.

F. Perform safety audits, inspections, meetings, and personnel interviews in accordance with federal, state, local, and Owner site safety rules and regulations.

G. Do not use the Architect’s construction observations as a substitute for Contractor’s safety audits and inspection responsibilities.

1.07 SUBSTITUTIONS

A. Conform to requirements of Division 1 [Section [[01 25 00]].

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Include, in each request for substitution, the following.

1. Product identification, manufacturer's name and address.
2. Product Data: Description, performance and test data, reference standards, finishes, and colors.
3. Samples: Finishes.
4. Complete and accurate drawings indicating construction revisions required to accommodate substitutions.
5. Data relating to changes required in construction schedule.
6. Cost comparison between specified and proposed substitution.

D. When approved substitute equipment or material necessitates revisions to the Drawings or involves other trades, include drawings and details showing such changes, and coordinate and assume any liability from the affected trades.

E. Acceptance: The acceptance of a manufacturer's name or product by the Architect does not relieve the Contractor of the responsibility for providing materials and equipment which comply in detail with the requirements of the Contract Documents.

F. The Contractor shall be liable for costs incurred by the Owner, Architect, and Engineer for professional services resulting from substitutions.

G. Substitutions will not be considered when they are indicated or implied on Shop Drawings or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

H. The Owner will be the final judge of acceptability, with review by Owner, and the distribution of the acceptance by the Architect. No substitute shall be ordered, installed or utilized without the Architect's prior written verification of acceptance from the Owner.

1.08 SEISMIC PERFORMANCE:

A. Rack, ceiling and wall mounted equipment and devices and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7. The

term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.09 SUBMITTALS

A. Conform to requirements of Division 1, [Section [01 33 00]].

B. Refer to individual Division 27 Specification Sections for additional requirements for submittals.

C. Submit information that is specific to this Project. Do not submit generic information. Highlight with yellow or blue marker adequate information to demonstrate materials being submitted fully comply with Contract Documents.

D. Do not use the submittal process to request substitutions. Make requests for substitution in accordance with Division 1, [Section [01 25 00]].

E. Product Data: Submit for approval manufacturer's descriptive product information including catalog cuts and other information required to confirm compliance with the Drawings and Specifications, including size, dimensions, model number, electrical characteristics, support requirements, connection requirements and all applicable information verifying that submitted components comply with Contract Documents.

F. Shop Drawings: Submit for approval shop drawings including floor plans with devices identified, wall and rack elevations, sections, schedules, wiring diagrams, schematics, seismic installation instructions, mounting details and other information required to confirm compliance with the Drawings and Specifications.

G. Schedule: Submit for approval a detailed schedule of the installation, testing and hand off to Owner of the Work.

H. Network Connections: Submit for approval a list of devices that will connect to the Owner's wired or wireless networked including the MAC address of the device, the location to be installed and the port configuration needed for connectivity.

I. Samples: Submit for approval samples to the Architect for color and material selection where the color or material selection is not specified.

J. Seismic Design: Submit calculations, details, Shop Drawings, Product Data, and statement of special inspections for the seismic design of nonstructural components, in Division 27 to Architect for Architect's review. After Architect's review, Architect will submit the Architect's notification with the calculations, details, Shop Drawings, and statement of special inspections to the Building Official per California Building Code section 107.3.4.1. Do not start Work until the calculations, details, Shop Drawings, Product Data, and statement of special inspections have been approved by the Building Official. If the Contractor hired professional engineer licensed in the State of California determines that the CBC does not require some of the nonstructural equipment to be

seismically restrained, then submit a stamped and signed statement from the professional engineer to that effect.

1. Submit a written “Contractor’s Statement of Responsibility”, where such statement is required by Section 1704.4 of the California Building Code, to Architect and to Building Official for electrical nonstructural components listed in the statement of

special inspections per California Building Code prior to the commencement of Work on the system or component.

K. Submit seismic certification of electrical nonstructural components and designated seismic systems where such certification is required by Section 1705.13 of the California Building Code.

1.10 QUALITY ASSURANCE

A. Conform to requirements of Division 1. [Section [01 43 00]].

B. Provide materials and equipment that are new, unused, free of defects, and of current manufacture. Equipment and materials shall carry Underwriters Laboratory certification if required by local, state or national codes.

C. Adhere to the Telecommunications Industry Association (ANSI/TIA) and Building Industry Consulting Service International (BICSI) recommended installation practices and manufacturer's guidelines when installing communications components.

1.11 QUALIFICATIONS

A. Conform to requirements of Division 1, [Section [01 43 13].

B. Manufacturer: Company specializing in manufacturing products specified in this Division with minimum 5 years documented experience.

C. Installation Contractor:
1. Specializes in the installing of products specified in this Division with minimum 3 years documented experience, and with service facilities within 100 miles of this Project.
2. Have factory certified technicians to work on any system software and programming of any devices installed on this Project.
3. Are familiar with local codes and contract conditions pertaining to this Project.
4. Have been distributing and/or installing the specific brand and model line of system equipment for at least 3 years prior to the date on the Contract Documents.
5. Have in-house engineering and project management capabilities consistent with the requirements of the Work.
6. Have a project manager and field supervisor in place which oversees the entire Project until completion of the Project including coordination, scheduling, staffing, functional performance testing for this Project.
7. Have a service facility and organization with staffing capable of providing comprehensive maintenance and service to the specified systems within 4 hours after being called, 24 hours per day and 7 days a week.

D. Testing Agency: Company specializing in testing products specified in this Section with minimum 3 years documented experience.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Conform to requirements of [Division 1], [Section [01 60 00].

B. Deliver materials (except bulk materials) in manufacturer's unopened containers, fully identified with the manufacturer's name, trade name, type, class, grade, size and color.

C. Store materials suitably sheltered from the elements, but readily accessible for inspection until installed. Store items subject to moisture damage in dry spaces.

[Coordinate requirement for storage space with Owner and identify where they will be located in submittals.]

D. Remove debris, packaging and waste materials for recycling and disposal from the job site each day.

1.13 AMBIENT CONDITIONS

A. Conform to requirements of [Division 1], [Section [01 89 00].

B. Assemble equipment and materials off-site whenever possible.

C. Install materials and equipment after the following.
   1. Spaces are enclosed and weather tight.
   2. Wet work in spaces is complete and dry.
   3. Movement of trades and the installation of other materials and equipment will not damage Work.
   4. The installation of materials and equipment in ceiling areas above Work is complete.

1.14 PROJECT MANAGEMENT AND COORDINATION

A. Conform to requirements of [Division 1], [Section [01 31 00]].

B. Refer to the Work of the Division 26 and 28 Section for location of devices, cables and connections that will interface with Division 27 Work.

C. Coordinate Work with that of the other trades doing Work on the Project. Examine the Drawings and Specifications of other trades for construction details and coordination.

D. [Sequence work to [_____].]

E. Refer to the Architectural Drawings for the exact height and location of all back boxes and equipment.

F. Refer to the reflected ceiling plan Drawings for the ceiling construction and height information and for the location of all back boxes and equipment.

G. Identify Work affecting other trades to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeves or other matters which will cause delays or necessitate work-around solutions.

H. Check space requirements and the physical confines of the area of work to ensure that all material and equipment can be installed in the spaces allotted thereto, including

conduits and cable supports. Bring space conflicts to the attention of the Architect for resolution.

I. [Due to the type of installation, a fixed sequence of operation is required to properly install the complete systems. Coordinate Project and schedule Work in accordance with the construction sequence. Maintain project schedules.]

J. [Attend construction meetings, at the Project site or other location, as requested by the Owner or Architect.]

K. Without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper compliance with the design intent.

L. Room numbers as shown on Contract Documents may not be final room numbers. Final room numbers will be provided during construction. Use final room number for labeling and programming of cables and devices that references room numbers. Use final room number in the preparation of record documents and O & M documents.

1.15 RECORD DRAWINGS

A. Conform to requirements of [Division 1], [Section [01 78 39]].

B. Project Record Documents: Provide the following.
1. Plan drawings and room elevation drawings showing actual locations and sizes of Work.
2. Show location of equipment and size of conduits, raceways, pathways, ducts, and cable trays.
3. Locations of fire or smoke rated floors and walls where communication pathways and cable pass through.
4. Duct banks and conduits installed below-grade shall be shown with both horizontal and vertical dimensions at an accuracy of plus or minus 6 inches.
5. Approved modifications to equipment in the field shall be shown on the record drawings to reflect the “as-built” conditions.
6. Record drawings shall be consistent. Changes made to plans, elevations, sections, wiring diagrams, schematics, or functional diagrams shall be made to

related or otherwise affected plans, elevations, sections, wiring diagrams, schematics, or functional diagrams.

C. Record documents shall be indented as “RECORD DOCUMENTS or-AS BUILT with the date of their preparation.

1.16 CLOSEOUT SUBMITTALS

A. Conform to requirements of [Division 1], [Section [01 78 23]].

B. [Format for Operating and Maintenance Manuals:
   1. Compile product data and related information appropriate for Owner’s maintenance and operation. Prepare data in instructional manual form for use by Owner’s personnel. Modify data as required to accurately represent completed installations.
   2. PDF files stored on 3 USB drives.
   3. Binders: Commercial quality, 3-hole punched, vinyl covered hardboard binder, secured with aluminum screw posts, sized for 8-1/2 inch by 11-inch sheet format. Do not exceed 3-1/2-inch binder width.
   4. Binder Cover: Identify each Manual with printed title, “OPERATING AND MAINTENANCE INSTRUCTIONS”, Project Title, identification of subject matter contained in manual, and completion date of Project. Include names of Owner, Architect, Contractor, and major equipment suppliers.
   5. Binder Edge: The binder edge shall be imprinted with the name of the job, Owner, and completion date of Project.
   6. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.
   7. Text: Manufacturer’s printed data, or neatly typewritten information on 20 pound white or off-white paper.
   8. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.]

C. Contents of Manuals:
   1. Project Directory: Indicate Project title and Project number. List Owner, Architect, [Commissioning Authority,]and Contractor with addresses, telephone numbers, and name of responsible parties.
   2. Product Directory: List names, addresses, and telephone numbers of subcontractors and suppliers. Included local sources of supplies and replacement parts. Provide information for re-ordering custom manufactured products.
   3. Product Data: Submit product literature. Mark each sheet to clearly identify specific products, models numbers, components parts, and data applied to

installation. Delete inapplicable information by marking out, striking out, or by notation.

4. Installation Instructions: Include instructions for installing equipment, devices, and systems. Instructions shall be specific to the installation and shall include pre-installation preparation, installation, and post-installation setup instructions.
5. Drawings and Diagrams: Include supplementing Product Data. Illustrate relations or components parts or equipment and systems. Show wiring, control, and flow diagrams. Do not use Project Record Documents as maintenance drawings.
6. Written Text: Include as necessary to supplement Product Data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
7. Provide information sheet for Owner's personnel indicating proper procedures in event of failure. Include instances which may affect validity of warranties.
8. Each Item of Equipment and Each System: Include description of system, and component parts. Include complete nomenclature and model number of replaceable parts. Identify the following.
   a. Normal functions.
   b. Normal operating characteristics.
   c. Limiting conditions.
9. Operating Procedures: Provide manufacturer's printed operation and maintenance instructions.
10. Maintenance Requirements: Include routine procedures and guide for preventive maintenance and troubleshooting; disassembling, repair, and reassemble instructions; and adjusting and checking instructions.
11. All warranty information shall include the following.
    a. Contractor/labor warranty (to include names and phone numbers).
    b. Parts/system/equipment specific warranties (to include complete list of components).]

1.17 WARRANTY

A. Refer to Division 01 for requirements for Warranties.

B. Provide originals of manufacturers' warranties to the Owner for Owner's records.

C. Register devices, components and systems with the manufacturer.

D. Provide a manufacturer's warranty for all work and all items of equipment and materials for a minimum period of one year, from the date of acceptance of the work, to cover for labor and material. Where a manufacturer's warranty is longer than one year, provide the extended warranty. Notify the Owner and Architect of any defective items. Repair or replace such items within 24 hours without cost to the Owner, all to the satisfaction of the Owner and Architect. If the failure exceeds 48 hours, the Owner reserves the right to

require the Contractor to provide on-site manufacturer support at no additional cost to Owner.

1.18 TRAINING FOR OWNER'S PERSONNEL

A. Refer to Division 01 for additional requirements for Training for Owner 's Personnel.

B. Refer to individual Division 27 Sections for additional requirements for Training for Owner's Personnel for specific systems.

C. Provide for approval a schedule of all Division 27 system training sessions prior to the commencement of training.

D. Provide qualified manufacturer trainers or qualified trainers certified by the manufacturers prior to the commencement of training.

E. Provide for approval qualifications for all Division 27 system trainers prior to the commencement of training.

F. Provide training materials for all training attendees.

G. General Description of Instruction Periods: Each period shall include preliminary discussion and presentation of information from operation and maintenance manuals with appropriate references to Drawings, followed by tours of equipment spaces explaining maintenance requirements, access methods, servicing, and maintenance procedures, temperature settings, and available system and equipment adjustments.

PART 2 - PRODUCTS

2.01 GENERAL

A. Subject to compliance with requirements, provide products by one of the manufacturers specified herein. Provide materials and equipment with performance levels and capacities as noted herein.

B. Part numbers provided in this Specification have been coordinated with the manufacturers' latest available product literature. Part numbers are subject to change without notice by the manufacturers. Where a specific part number is invalid, coordinate for approval products meeting component description.

C. Where specific items are called out in the Specification or indicated on the Drawings for a specific application, use those products or materials, or approved substitutes. Where no specific call outs are made, provide premium products and materials. All materials and equipment installed shall have been tested and listed by Underwriters Laboratories

or other approved testing organization and shall be so labeled unless otherwise permitted by the authority having jurisdiction (Inspector).

D. All materials to be new, free from defects and not less than quality herein specified. Materials shall be designated to ensure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.

E. Each type of materials furnished shall be of the same make, be standard products of manufacturers regularly engaged in production of such materials and be the manufacturer's latest standard design.

2.02 EXAMINATION OF DOCUMENTS

A. Before submitting a bid, visit the Project Site and become familiar with conditions which may be pertinent to, or affect the cost of, the electrical installation.

B. Become acquainted with the Work of other installers whose activities will adjoin or be affected by the electrical Work. Consult with these other installers and study all pertinent Drawings in order to coordinate the Work and to avoid conflicts, omissions and delays.

C. Before submitting a bid, examine all pertinent Contract Documents for electrical requirements which are not necessarily indicated on the electrical Drawings and include in the bid a sum which is sufficient to cover the costs of these other requirements.

D. Should it be perceived that the Contract Documents do not sufficiently define the required electrical work, contact the Architect for clarification or further description. Failure to do this will be construed as evidence of an understanding of the required electrical systems and their installation.

2.03 PERMITS AND FEES

A. Contractor shall be responsible for obtaining and paying for all necessary electrical permits and fees.

B. The following section should be deleted if project is new construction.

2.04 EXISTING FACILITIES

A. Examine the drawings and specifications of the completed work and inspect the site to establish the scope of demolition work and new work to be provided under this sections and clarification of the phasing of the work.

B. Based on project phasing and scheduling, demolition work will be taking place in and around existing areas that are to remain in service. Where the work under this section affects or interferes with the operation of any existing areas to remain in service, or portions of the work already in operation, provide all necessary work and material including premium pay, required to avoid shutdown of these areas during normal

operations. Obtain Owner's approval for shutdown, in writing, 48 hours prior to shut down.

PART 3 - EXECUTION

3.01 GENERAL

A. Follow manufacturers' instructions for installing materials and equipment and adjusting equipment and cables. Where no instructions are included with the equipment, call manufacturer to obtain detailed instructions, document instructions, and follow those instructions.

B. Sequence, coordinate, install and integrate the various elements of these Specifications and Drawings.

C. Install equipment level and plumb.

D. Verify field conditions and dimensions in the field prior to commencement of Work. Do not block access or service clearance on equipment of these or of the Specifications of other Divisions.

E. Keep all items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures throughout the life of the Project.

F. Protect materials and equipment from damage. Do not install materials and equipment in the communications rooms or Work areas until the other trades have completed their Work in the areas so that the equipment will not be stepped on, moved, or damaged.

G. Provide and maintain safe ingress and egress from Work areas.

H. Deliver to Owner sets of specialty tools specifically needed for proper operation, adjustment and maintenance of cable and cable termination hardware installed under this Contract.

I. Attend meetings as scheduled by the Owner and Architect.

3.02 DEMOLITION AND REMOVAL

A. Cut, remove, and legally dispose of selected equipment, components, and materials [as indicated on the Drawings].

3.03 DRAWINGS

A. For purposes of clarity and legibility, the [Technology] Drawings are essentially diagrammatic. although the size and location of [Technology] equipment is drawn to

scale wherever possible, make use of all data in all the Contract Documents, and verify this at the Project Site. Determine the exact location of conduits, outlets and equipment by the study of details, shop drawings and/or the Architect's directions.

B. The [Technology] Drawings show the required size and points of termination of the conduits and the quantity and size of the conductors within. However, the Drawings do not show all the necessary conduit routing. Install conduits in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep passageways and openings clear.

C. Locate outlets symmetrically with architectural elements, notwithstanding the fact that the locations shown of the electrical drawings may be distorted for clarity of representation.

D. The architectural Drawings take precedence over the electrical Drawings. Study the reflected ceiling plans and interior elevations to determine the exact location of lighting fixtures, wall-mounted devices and fixtures, etc. The Architect has taken a very active role in the placement of these items. Should there be a conflict between locations shown on the architectural and electrical drawings, contact the Engineer for clarification prior to rough-in.

3.04 VERIFICATION OF AVAILABLE SPACE

A. Throughout the course of construction, verify that sufficient space will be available for the equipment their required clearances to be installed. If conflict determined, contractor shall contact the design team for clarification on how to proceed.

3.05 EXISTING FACILITIES

A. Based on project phasing and scheduling, demolition work will be taking place in and around existing areas that are to remain in service. Where the work under this section affects or interferes with the operation of any existing areas to remain in service, or portions of the work already in operation, provide all necessary work and material including premium pay, required to avoid shutdown of these areas during normal

operations. Obtain Owner's approval for shutdown, in writing, 48 hours prior to shut down.

B. Existing electrical and signal facilities outside of the demolition area to remain in place and in-service during demolition.

C. Where areas of existing facilities are indicated to be demolished or remodeled, relocate electric and signal system equipment, and reroute or replace conduit and wiring as required to conform with new use of the area and maintain operation of adjacent areas.

D. Unless specifically noted or otherwise indicated or directed, remove all existing electrical equipment in the areas to be demolished. Deliver all equipment removed, including lighting fixtures, to the Owner's representative

E. Where remodeling of existing areas is indicated, provide all work indicated and required for a complete and operating facility. Where work is adjacent to existing fixtures or devices, provide matching products to present uniform appearance. Salvage demolished material and equipment and deliver to Owner as directed. Dispose of salvaged materials and equipment where so directed in writing by Owner. Patch all openings in existing walls or floors caused by removal of materials and/or equipment under this work.

3.06 WATERPROOFING

A. Wherever electrical Work pierces waterproofing or waterproofing membranes, install it in an approved watertight manner.

3.07 INSTALLATION

A. Comply with BICSI TDMM, and the TIA -568, TIA -569, TIA -606, and TIA 607-A standards.

B. Comply with applicable federal, state and local requirements, codes and ordinances of authorities having jurisdiction.

C. Comply with manufacturers' specifications, installation manuals, and published recommendations and best practices.

3.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials and equipment according to the manufacturer's recommendations, using means and methods that shall prevent damage, deterioration,

and loss, including theft. Handle equipment carefully to prevent damage, breakage, denting, and scoring of finishes. Replace damaged equipment.

B. Store products subject to damage by the elements above ground, undercover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

3.09 CUTTING AND PATCHING

A. Provide core drilling, cutting and patching of existing construction and surfaces for the installation of communication systems. Concrete, asphalt or plaster surfaces which have been damaged by such drilling or cutting shall be patched and repaired to match the surrounding surface.

3.10 ADJUST AND CLEANLLL

A. Keep the Project Site free from accumulations of rubbish and debris. Remove such accumulations from the Project Site.

B. Thoroughly clean equipment and materials of plaster, cement and other foreign materials and leave smooth, clean and dry.

3.11 CYBERSECURITY PROTECTION

A. For installed systems that have internet connectivity, including but not limited to controls, monitoring, metering, sensors, or other remote access capabilities, the General Contractor is responsible to request from its subcontractors a cybersecurity risk mitigation plan. All cybersecurity risk mitigation plans shall be coordinated with the owner to verify functionality and compatibility with the owner’s network architecture and topology. Cybersecurity risks to be mitigated include intrusion, remote access, viruses, spy-ware, and malware. Put in-place and in-use effective protection and homogenous policies for infrastructure, servers, workstations, controllers, network connected equipment, internet connected systems/devices, Wi-Fi devices, IOT devices and mobile

devices. Where relevant and applicable, apply the requirements of ISO/IEC 27000 Series of Standards relating to “Information Technology - Security Techniques”.

B. For “highly secure environments” identified by the Owner, implement relevant jurisdiction-specific standards to be performed by an accredited Information Security advisor.

3.12 CONSTRUCTION ADMINISTRATION

A. Substitutions
   1. Refer to other Sections of these Specifications for substitution requirements.

B. Submittals
   1. All submittals shall be provided in electronic format for review.
   2. All submittals associated within a single specification section shall be submitted as a single package. Piecemeal submittals will be rejected as incomplete.
   3. Re-submittals shall only include the requested resubmittal documentation. A complete resubmittal including approved equipment and materials will be rejected.
   4. If an error in the submittals is not detected during the review process, this does not grant the contractor permission to proceed in error. Regardless of any information contained in the submittals, the requirements of the drawings and specifications must be followed and are not waived or superseded by the submittal review. Any

conflicting information shall be brought to the attention of the engineer and design team through the RFI process.

C. Requests for Information (RFIs)
   1. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 1).
      a. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
      b. RFIs shall address single questions and related issues only.
      c. All RFIs shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to Owner’s Design Representative.
   2. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
      a. Project name.
      b. Project number.
      c. Date.
      d. Name of Contractor.
      e. Name of Architect [and Construction Manager].
      f. RFI number, numbered sequentially and unique.
      g. RFI subject.
      h. Specification Section number and title and related paragraphs, as appropriate.
      i. Drawing number and detail references, as appropriate.
      j. Field dimensions and conditions, as appropriate.
      k. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
      l. Contractor's signature.
      m. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
      n. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
   3. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response for each RFI, plus additional time for Architect and General Contractor to review and

forward. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

a. The following Contractor-generated RFIs will be returned without action:
b. Incomplete RFIs or inaccurately prepared RFIs.
c. RFIs submitted without indication of review and approval for submission by General Contractor.
d. RFIs addressing multiple unrelated issues.
e. Requests for approval of submittals.
f. Requests for approval of substitutions.
g. Requests for approval of Contractor's means and methods.
h. Requests for information already indicated in the Contract Documents.
i. Requests for adjustments in the Contract Time or the Contract Sum.
j. Requests for interpretation of Engineer's actions on submittals.
k. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

D. Installation Drawings
1. Prepare dimensionally accurate floor plans of each electrical and signal room and/or closet, fire control room and the like, drawn to 1/4" scale minimum. Submit electronic copies for review with two prints for Architect's record. Indicate all equipment within the rooms to scale based on shop drawing data, include structural support for suspended equipment and description of seismic bracing and fastening. Indicate system and equipment grounding details as applicable. Review elevator machine room shop drawings and coordinate location of electrical gear to maintain clearances. Submit with shop drawings.
2. Where conduit runs, 2" trade size and larger, are run in exposed locations, prepare dimensionally accurate floor plans indicating routing, coordinated with work of other trades and the structure. Submit legible reproducible transparencies with two prints for review.

E. Project Record Documents
1. Maintain Record Documents which clearly indicate variances from the specified systems, and which accurately locate all underground electrical conduits and structures.

3.13 SEISMIC AND WIND RESTRAINTS

A. Seismic Restraints: Seismically restrain equipment, pull boxes, cable tray and conduit in accordance with the requirements of the California Building Code. Design of seismic restraints shall allow for the stress and thermal expansion of cable tray and conduit. Nonstructural components in Division 27 shall be as defined by ASCE 7.
1. Obtain the services of a professional engineer licensed in the State of California to prepare the seismic design for nonstructural components. The professional engineer licensed in the State of California shall also prepare a statement of special inspections per requirements of the California Building Code where such

statement is required by Code. Submit calculations, details, Shop Drawings, Product Data, and statement of special inspections for the seismic design of equipment, pull boxes, cable tray and conduit. If the professional engineer determines that the California Building Code does not require some of the nonstructural components be seismically restrained, then submit a stamped and signed statement from the professional engineer to that effect.

2. Seismic Certification of Nonstructural Components: Submit manufacturer's certification by analysis, testing, or experience for nonstructural components and designated seismic systems in accordance with Section 13.2 of ASCE 7, where such certification is required by Section 1705.13 of the California Building Code

B. Wind Restraints: Restrain components located outside in accordance with the wind requirements of the California Building Code.
   1. Obtain the services of a professional engineer licensed in the State of California to prepare wind restraint design for electrical equipment located outside. Submit

calculations, details, Shop Drawings, and Product Data for wind restraints for electrical equipment.

C. The professional engineer obtained by the Contractor shall prepare both seismic and wind designs.

3.14 FIRESTOPPING

A. Provide fire-stopping materials to penetrations of fire or smoke rated floor and wall assemblies to maintain fire-resistance rating of the associated assembly in accordance with Division 07 requirements.

B. Apply materials as part of an approved UL Certified Firestop system.

C. Apply materials in environmental conditions (temperature, humidity. vibration and cleanliness) acceptable to the Manufacturer of the firestop system.

D. Refer other Division 27 Specifications for the installation requirements for cables.

E. Provide labels at fire-stopped locations which indicate the UL system, material manufacturer and lot number, code and serial number.

3.15 CLEAN UP

A. Continually remove debris, cuttings, crates, cartons, etc., created by Work. Clean daily and at enough frequency to eliminate hazard to public, other workers, the building or Owner staff.

B. Perform final cleaning including the following.
1. Carefully clean cabinets, wiring devices, cover plates, etc. to remove dirt, dust, lubricant, cuttings, paint, plaster, mortar, concrete, etc.
2. Touch-up scratched or damaged finished surfaces to match factory finish.

END OF SECTION

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes providing materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of a grounding and bonding system for communications system.

1.02 REFERENCES

A. UL 467 (Underwriters Laboratory) – Grounding and Bonding Equipment.

B. ANSI/TIA 607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

C. BICSI Telecommunications Distribution Methods Manual (TDMM), Fourteenth Edition.

1.03 ACTION SUBMITTALS

A. Product Data:
   1. Materials list.
   2. Technical data (cut sheets) for on each component.

B. Shop Drawings:
   1. Exact location of busbars in communication rooms, refer to Section 27 11 00.
   2. Route of bonding conductors and interconnection with the electrical systems grounding and bonding system.

1.04 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
   1. Main electrical bonding bus bar.
   2. Primary bus bar (PBB), secondary bus bars (SBBs) telecommunication bonding backbones (TBBs) and routing of their bonding conductors.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual routing of backbone bonding conductors and bonding busbars.

B. Ground resistant test results

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be always present when Work of this Section is performed at Project site.
   2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

1.07 COORDINATION

A. Coordinate the bonding of communication bonding busbars and conductors with the Work of Division 26 05 26 Grounding and Bonding for Electrical Systems.

B. Coordinate the bonding of communication cable trays with the Work of Section 27 05 30 Hangars and Supports for Communication System Cables.

C. Coordinate the bonding of communication cable conduits and sleeves with the Work of Section 27 05 28 Conduits and Back Boxes for Communication Systems.

D. Coordinate the bonding of equipment rack and equipment cabinets in the communication rooms with the Work of Section 27 11 00 Communication Equipment Room Fittings.

PART 2 - PRODUCTS

2.01 COMPONENTS

A. Comply with UL 467 for grounding and bonding materials and equipment.

B. Comply with TIA-607

2.02 CONDUCTORS

A. Manufacturers::
   1. Harger Lightning & Grounding; business of Harger, Inc.
   2. Panduit Corp.
   3. TE Connectivity Ltd.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

2.03 CONNECTORS

A. Manufacturers:
   1. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. Chatsworth Products, Inc.
3. Cooper B-Line.
4. ERICO.
5. Hubbell.
6. Panduit Corp.
7. TE Connectivity Ltd.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Two Hole compression lugs/connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

2.04 BONDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Products, Inc.
2. Harger Lightning & Grounding; business of Harger, Inc.
3. Panduit Corp.

B. Primary Bonding Busbar (PBB): Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, **1/4 by 4 inches (6.3 by 100 mm)** 20’’L in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607.
1. Predrilling shall be with double holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Secondary Bonding Busbar (SBB): Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) 12’’ in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607.
1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm) long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 IDENTIFICATION

A. Manufacturer: ACP International, Part # CT100.

B. Plastic cable tags with “WARNING, DO NOT REMOVE THIS GROUND. SHOULD IT BECOME LOOSE OR NEED TO BE REMOVED, CONTACT FACILITIES.” and space for cable information, complete with cable ties.

C. Size: 1.5” x 3.0”

D. Color: Orange with black lettering.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the AC grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of bonding conductor connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the bonding conductor only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Include the AC utility power service entrance, the communications cable entrance, and the grounding electrode system to form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607.

D. Bonding Conductors:
1. Provide bonding conductors as shown on the Drawings. Install bonding conductors in continuous lengths. Do not daisy-chain bonding conductors between bonding busbars with non-continuous bonding conductors.
2. Provide bonding conductors from the electrical primary bonding busbar to the communication primary bonding busbar.
3. Provide bonding conductors from the communication primary bonding busbar to the communication secondary bonding busbars.
4. Provide bonding conductors from the communication bonding busbars to:
   a. Building steel if available.
   b. The electrical panel serving the communication rooms.
   c. To the conduits entering the communication rooms. Refer to 27 05 30 for additional information.
   d. To the cable trays entering the communication rooms.
   e. To the cable trays in the communication rooms. Refer to 27 05 28 for additional information.
   f. To the equipment racks, cabinets and enclosures installed in the communication rooms. Refer to 27 11 00 for additional information.
   g. To the bonding busbar to a second communication room on the same floor of the building at the top of the building and every third floor.
5. Remove paint from painted metal components where bonding/ground lugs contact metallic components.
6. Apply antioxidant joint compound where metallic components contact bonding/ground lugs.
7. Using a crimping tool to connect the bonding conductors to the lugs. Do not use pliers or hammers. Use the proper die in the crimping tool to match the diameter of the lug/bonding conductor.
8. Visibly inspect the inspection port of the lug to ensure proper contact was made with the bonding conductor.
9. Provide a minimum 8-inch bend radius for bonding conductors connected to primary or secondary bonding busbars.
10. Provide a bending radius of a minimum 10X outside diameter of a bonding conductors along its run.

11. When inside a communication room, route bonding conductors toward the bonding busbar. Do make U-turns in the route of the grounding conductor.

E. Bonding Conductor, Telecommunication Bonding Backbone and Backbone Bonding Conducting Sizing Table:

Linear Length (Feet)	Conductor Size (AWG)
Less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

1. The Telecommunication Bonding Conductor shall be the same size as the Telecommunication Bonding Backbone.
2. The Backbone Bonding Conductor shall be, as a minimum the same size as the largest Telecommunication Bonding Backbone to which it is connected.

F. Bonding Busbars:
1. Attach the bonding busbars to the walls in the communication rooms and equipment rooms at locations shown on the Drawings. Provide isolators and appropriate hardware according to the manufacturer's installation instructions.
2. Clean the bonding busbars with abrasive pads to remove oil and dirt.
3. Make connections with two-hole bolt-on compression lugs sized to fit the bonding busbar and the conductors. Connect each lug with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the bonding busbar with antioxidant joint compound.

3.03 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
1. The bonding conductors between the BB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:
1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).

E. Grounding and Bonding Conductors:
1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM

A. The bonding conductor between the PBB and the AC service equipment ground shall not be smaller than No. 3/0 AWG.

3.05 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.06 CONNECTIONS

A. Bond metallic equipment in a communications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
    1. Use crimping tool and the die specific to the connector.
    2. Pre - twist the conductor.
    3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the PBB with insulated bonding conductor.

E. Interconnections: Interconnect all SBBs with the PBB with the telecommunications backbone conductor. If more than one PBB is installed, interconnect PBBs using the grounding equalizer conductor. The communications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Communications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the BBs No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for communications equipment is located in the same room or space, bond each BB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the BBs in communications rooms and spaces. Comply with TIA-568 when grounding shielded balanced twisted-pair cables.

J. Equipment Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.

3.07 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

B. Comply with IEEE C2 grounding requirements.

C. Grounding Utility Vaults and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, no-shrink grout.

D. Grounding Connections to Utility Vaults and Handholes Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each utility vault or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors to be level and plumb

around corners and fasten to utility vault or handhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.08 IDENTIFICATION

A. Affix a machine generated cable tag on backbone cables where they bond to bonding busbars. Affix a machine generated label with the following wording on all backbone cables where they bond to grounding busbars, “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT. IF CONNECTORS ARE LOOSE OR MUST BE REMOVED, CALL THE NETWORK/COMMUNICATION MANAGER FOR APPROVAL”.

B. Labels shall be preprinted or computer-printed type.
   1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
   2. Label SBB(s) with "fs-SBB," where "fs" is the telecommunications space identifier for the space containing the SBB.

3.09 QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. The maximum acceptable connection resistance and AC loop current values are based on recommendations of BICSI TDMM.

D. Tests and Inspections:
   1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
      a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
   3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
      a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.

E. Excessive Ground Resistance: If resistance to ground at the bonding conductors exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28 – CONDUITS AND BACK BOXES FOR COMMUNICATION SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes materials, equipment, labor, supervision, tools, and items necessary for the construction and installation of conduits and back boxes for communication systems.

1.02 RELATED SECTIONS

A. Section 07 84 13, Penetration Firestopping.

B. Section 26 05 33, Raceways and Boxes.

C. Section 26 05 43, Underground Ducts and Raceways for Electrical Systems.

D. Section 27 05 00, Common Work Recuts for Communication Systems

E. Section 27 05 26 Grounding ad Bonding for Communication Systems.

F. Section 27 05 43, Underground Pathways and Structures for Communication Systems.

1.03 REFERENCES

A. ANSI C80.3 (American National Standards Institute) - Electrical Metallic Tubing, Zinc Coated.

B. NEC

C. NESC.

D. National Electrical Manufacturers Association:
   1. NEMA TC-3-04 PVC Fittings for Use with Rigid PVC Conduit and Tubing
   2. NEMA FB1-03 NEMA FB 1 (National Electrical Manufacturers Association) – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   3. NEMA OS 1 Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

E. Underwriters Laboratories, Inc.:
   1. UL 1-03 Flexible Metal Conduit
   2. UL 5-01 Surface Metal Raceway and Fittings
   3. UL 6-03 Rigid Metal Conduit
   4. UL 50-03 Enclosures for Electrical Equipment

5. UL 360-03 Liquid-Tight Flexible Steel Conduit
6. UL 467-01 Grounding and Bonding Equipment
7. UL 514A-01 Metallic Outlet Boxes
8. UL 514B-02 Fittings for Cable and Conduit
9. UL 514C-05 Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
10. UL 651-02 Schedule 40 and 80 Rigid PVC Conduit
11. UL 651A-03 Type EB and A Rigid PVC Conduit and HDPE Conduit
12. UL 797-03 Electrical Metallic Tubing
13. UL 1242-00 Intermediate Metal Conduit
14. UL-1479 Fire Tests of Through Penetration Firestops
15. UL 1684 Fiberglass Conduit Above Ground

1.04 ACTION SUBMITTALS

A. Product data:
   1. Materials list.
   2. Technical data (cut sheets) for on each component

B. Shop Drawings:
   1. Floor Plans showing the routes and locations of the following.
      a. Conduits with an internal diameter of greater than 2 inches.
      b. Conduit sleeves installed in the floor and ceiling of communication rooms.
      c. Conduits through smoke and fire rated floors and walls.
      d. Pull boxes.
      e. Conduit installed concealed in slab.
      f. Conduits installed above inaccessible ceilings.
      g. Conduit for floor boxes and poke through devices installed in the ceiling of the floor below.
      h. Conduit installed external to the building.
      i. Back boxes installed in fire rated walls.

C. Firestop design basis documentation for each type of communication penetration, type of building construction being penetrated including the hourly resistance rating of floor, wall, or other partition of building construction into which firestop design will be installed, and firestop device or system proposed for use.

D. Sample firestop system labels.

E. CLOSEOUT SUBMITTALS
   1. Project Record Documents: Record actual routing and locations of the following items:
      a. Conduits where any section of the conduit run meets the following conditions.
      b. Internal diameter greater than 2 inches.
      c. Installed in the floor and ceiling of communication rooms.
      d. Installed concealed in slab.
      e. Installed above inaccessible ceiling.

f. Installed outside of building.
g. Installed through fire or smoke rated walls or floors.

2. Pull boxes.
3. Locations where firestopping system have been applied.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from the entrance of dirt, dust, moisture, and debris.

1.06 COORDINATION

A. Coordinate installation of back boxes with back boxes installed under Sections 26 05 33

B. Coordinate mounting heights, orientation and locations of back boxes mounted above counters, benches, and backsplashes.

C. Obtain and review shop drawings for furniture systems and mill work where conduits will run into the furniture and mill work for cable distribution within.

D. Coordinate the installation of conduits in the floors, ceiling, or side wall of communication rooms with Section 27 11 00 Work.

E. Coordinate the installation of conduits in fire or smoke floors and walls with the Architect for acceptable spacing of conduits and methods of firestopping of the conduits and the cables to installed within.

F. Coordinate the bonding of sleeves and conduits with the bonding busbars installed under Sections 26 05 26 and 27 05 26.

G. Coordinate the installation of conduit in concrete slabs and other structural members. with the Division 03 Work prior to installation

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
2. AFC Cable Systems; Atkore International.
3. Allied Tube & Conduit; Atkore International.
4. Alpha Wire.
5. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.

6. Plasti-Bond; Robroy Industries.
7. Prime.
8. Southwire Company.
9. Wheatland.

C. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with ANSI/TIA-569.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. ARC: Comply with ANSI C80.5 and UL 6A.

F. IMC: Comply with ANSI C80.6 and UL 1242.

G. PVC-Coated Steel Conduit: PVC-coated GRC.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:
a. Material: Steel or die cast.
b. Type: Compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions depending where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
2. AFC Cable Systems; Atkore International.

3. Allied Tube & Conduit; Atkore International.
4. Cantex Inc.
5. CertainTeed LLC; Saint-Gobain North America.
6. Condux International, Inc.
7. Dura-Line.
8. Dura-Line Communications Group; Orbia Advance Corporation, S.A.B. de C.V.

C. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with ANSI/TIA-569.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Rigid HDPE: Comply with UL 651A.

F. Continuous HDPE: Comply with UL 651A.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

H. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

I. Solvents and Adhesives: As recommended by conduit manufacturer.

2.03 EXPANSION/DEFLECTION FITTINGS

A. Description: Non-Metallic expansion/deflection coupling to join PVC conduits across structural joints. Complete with inner sleeve couplers, neoprene outer jackets with tamperproof steel straps. Suitable for use to join Schedule 40 conduits. Allows ¾ inch axial or parallel deflection and 40-degree angular deflections.

2.04 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum riser or general-use installation unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
2. Alpha Wire.
3. Endot Industries Inc.
4. IPEX USA LLC.
5. Maxcell

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.05 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-line; brand of Eaton, Electrical Sector.
2. Hoffman; brand of nVent Electrical plc.
3. MonoSystems, Inc.
4. Square D; Schneider Electric USA.

C. General Requirements for Metal Wireways and Auxiliary Gutters:
1. Comply with UL 870 and NEMA 250, unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Wireway Covers: Hinged type unless otherwise indicated.

F. Finish: Manufacturer's standard enamel finish.

2.06 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
2. Allied Moulded Products, Inc.
3. Hoffman; brand of nVent Electrical plc.
4. Niedax Inc.

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.07 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. MonoSystems, Inc.
2. Niedax Inc.
3. Panduit Corp.
4. Wiremold; Legrand North America, LLC.

C. Finish: Manufacturer's standard enamel finish in color selected by Architect.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.08 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
2. MonoSystems, Inc.
3. Panduit Corp.
4. Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated.

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.09 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB, Electrification Business.
   2. Adalet.
   3. Arlington Fittings
   4. Bowers.
   5. Crouse-Hinds; brand of Eaton, Electrical Sector.
   6. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
   7. Erickson Electrical Equipment Company.
   8. FSR Inc.
   9. Hubbell.
   10. Orbit
   11. Raco.
   12. Randl.
   13. Steel City.

C. General Requirements for Back Boxes, Enclosures and Cabinets:
   1. Comply with TIA-569-D.
   2. Boxes and enclosures installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
   3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).
   5. Size: 2-inch buy 4-inch, 2-1/2-inch-deep box, with knockouts for 3/4-inch, 1-inch, and 1 1/4-inch conduits and a 5/8-inch deep single, single gang mud ring.
   6. Size: 4-11/16-inch square, 2-1/2 inch deep, box, with knockouts for 3/4-inch, 1 inch, and 1 1/4-inch conduits and a 5/8 inch deep single gang mud ring.
   7. Size: 5-inch square 2-7/8-inch-deep box with knockouts for 1 inch, 1-1/4 inch, 1-1/2 inch and 2-inch conduits, with internal cable managers and a 5/8-inch-deep mud ring.
   8. Size: 5-inch square 3 1/4-inch-deep box with knockouts for 1-1/4 inch and 2-inch conduits and a 5/8-inch-deep mud ring.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

F. Metal Floor Boxes:
   1. Material: Cast metal or sheet metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.

4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.
1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

L. Cabinets:
1. NEMA 250, Type 1, Type 3R, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.10 ACCESSIBLE CEILING T-BAR BACK BOX HANGAR
1. Manufacturers.
a. Caddy - Part # 51220A
b. Or approved equal.
2. Spanner bar to support back box above an accessible ceiling tile, complete with Tee bar mounting clips, back box mounting clip, fixture mount stabilizer clip and slack/drop wire to secure to structure above

2.11 GYPBOARD CEILING BACK BOX HANGAR

A. Manufacturers.
1. Caddy - Part # TCB
2. Or approved equal.

B. Spanner bar to support back box above a gypsum board ceiling, complete with spanner mounting clips, back box mounting clip, fixture mount stabilizer clip and slack/drop wire to secure to structure above

2.12 CABLE ENTRY PORTS/GLANDS

A. Manufacturers.
1. Leviton.
2. Panduit
3. Or approved equal.

B. Non-metallic, round or rectangle/square frame with cable ports with integrated water-sealing Polymer membranes, suitable for terminated and un-terminated cables.

2.13 CABLE ENTRY COVER

A. Manufacturers.
1. Arlington Fittings
2. Or approved equal.

B. Non-metallic, brushed cable entry device.

2.14 FLOOR BOXES

A. Refer to Section 26 05 33 – Raceways and Boxes for floor boxes.

2.15 WIRELESS ACCESS POINT BRACKETS

A. Manufacturer:
1. Oberon
2. Or approved equal.

B. Brackets to support and maintain a horizontal plane of an access point, suitable for use in gypsum board ceilings.

C. Brackets to support and maintain a horizontal plane of an access point, suitable for use in accessible tile ceilings.

D. Brackets to support and maintain a horizontal plane of an access point, suitable for use on wall accessible tile ceilings.

2.16 OUTDOOR RATED ENCLOSURE

A. Small Enclosures (12 inches by 12 inches):
1. 304 stainless steel NEMA 4R with screw on cover.

B. Large Enclosures (greater than12 inches by 12 inches):

1. 304 stainless steel, NEMA 4R hinged cover with keyed lock.

C. Wireless Access Point Enclosures:
1. Manufacturer:
2. Oberon part Number 1024-00 or approved equivalent.
3. Polycarbonate, radio frequency signal transparent, NEMA 4X, hinged cover with lock.

2.17 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Hoffman.
2. Cooper B-Line.
3. Or approved equal.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
1. Screw on Cover: Where pull box covers are smaller than 576 square inches in surface area.
2. Hinged Cover: Where pull box covers are 576 square inches in surface area or larger.
3. Captive Cover Hardware: Where pull boxes opening faces downward or where dropping the cover has the potential for a safety hazard.

2.18 OUTLET DEVICE RING

A. Single gang device ring for wall phones communication outlets.

B. Double gang device ring for all communication outlets or as noted on the drawings.

2.19 DEVICE COVER PLATES

A. Refer to Section 26 27 26 for requirements to match the style, color and material for back box cover plates for all unwired or conduit only communication outlets.

B. Refer to Section 27 15 00 for communication outlet cover plate requirements.

2.20 STUD BUSHINGS

A. Plastic bushing to cover knock-outs in metal studs.

B. Manufacturer: Arlington Part # SB13, or approved equivalent.

2.21 FIRE RATED SLEEVES

A. Fire Rated Sleeve Assemblies Installed Through Rated Construction:
1. Meet the hourly rating of rated wall and or floor penetrated.
2. Be tested for the surrounding construction and cable types involved.

3. Have UL Systems permitting cable loads from; “Zero to 100% Visual Fill.”
4. Be “Zero-Maintenance”, zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to the following.
   a. Opening or closing of doors.
   b. Spinning rings to open or close fabric liner.
   c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
5. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
6. Pathways shall be engineered to be re-enterable, so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
7. Cable Pathway Devices passing vertically through floors shall have equal F & T Rating. (See UL System # F-A-3037, Item #4 “EZ-PATH Grid T-Rating Kit” Part # TRK444).

B. Square New:
1. 4 inches by 4 inches fire-rated sleeves, complete with intumescent material, associated frames and radius control modules].
2. Complete with wall plate, wall frames, brackets, floor grid frame, radius control modules and labels.
3. Manufacturer:
   a. Specified Technologies Inc., part number EZD44S2.
   b. Or approved equivalent.

C. Round New:
1. Manufacturer:
   a. Hilti Corporation, part number P653 4 inches Speed Sleeve.
   b. Or approved equivalent.
2. 4-inch round fire rated sleeves, complete with intumescent material and associated support rings.
3. Manufacturer:
   a. Hilti Corporation, part number CFS-SL GP, CFS-SL-GO, CFGS-MS CFS-SL GP gang plate.
   b. Or approved equivalent.

2.22 SMOKE AND ACOUSTICAL SLEEVES

A. Cable Assemblies Installed Through Non-Fire Rated Construction
1. Manufacturer:
   a. Specified Technologies Inc., part number NEZ33.
   b. Or approved equivalent.
2. 3 inches by 3 inches non-fire rated split sleeves, complete with acoustical material. Suitable for use in framed dry walls.
3. Complete with plates, frames, brackets and labels.

B. Cable Assemblies Installed Through Non-Fire Rated Construction
   1. Manufacturer:
      a. Specified Technologies Inc., part number NEZ44, NEZD344, NEZ44D544.
   2. Or approved equivalent.
   3. 4 inches by 3 inches non-fire rated split sleeves, complete with acoustical material. Suitable for use in framed dry walls.
   4. Complete with ganging frames and labels.

2.23 PATHWAY FIRESTOPPING WRAP

A. Manufacturer:
   1. Specified Technologies Inc., part number E-Wrap.
   2. Or approved equivalent.

B. Circuit Integrity Cable Pathways:

C. Conduit endothermic wrap incorporating foil scrim.

2.24 CABLE TRAY FIRE STOP DEVICE

A. Manufacturer:
   1. STI part # EZCTR612, EZCTR614, EZCTR616, EZCTR618,.
   2. Or approved equivalent.

B. UL Classified.

C. Product Description: Fire rated wall pass through flange and collar, suitable for retrofit application, suitable for use in concrete and gypsum board

2.25 BACK BOX FIRESTOPPING WRAP/INSERT

A. Back Boxes in Fire Rated Construction:
   1. Manufacturer:
      a. Specified Technologies Inc., part number, EP44, EP45.
      b. Or approved equivalent.
   2. Endothermic wrap/putty pads/inserts.

2.26 FIRESTOP PLUGS

A. Manufacturer:
   1. Specified Technologies Inc., part number 5GKD4 5GKD5.
   2. Or approved equivalent.

B. Re-enterable firestop plugs for insertion into conduits/sleeves.

C. UL classified.

2.27 CABLE SPILL WAYS

A. Manufacturers:
1. BEJED - Part # BJ-2049
2. Panduit – Part # CWF400.
3. Or approved equivalent.

B. Conduit spill way extensions with 90-degree bends, 12 inches long, with ratchets clamp connectors and Velcro straps for cable retention, suitable for use on 4-inch metallic conduit/sleeves.

2.28 SPLIT DUCT

A. Manufacturers:
1. Panduit – Part # CLT 188F-C20.
2. Or approved equivalent.

B. Constructions: Corrugated round duct, split entire length to wrap around communication cables.

C. Minimum inside diameter: 1.75 inches.

D. Color: Black

2.29 PULL CORDS

A. Nylon pull-cords with a minimum 200-pound tensile strength.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturer’s instructions for installation of products.

B. Verify outlet and pull box locations, and the routing of conduits prior to rough-in. Report space or access conflicts to the Architect.

C. Refer to Architectural drawings for ceiling construction and fire or smoke rated wall/floors construction locations and details.

3.02 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC RNC, Type EPC-40-PVC RNC, Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: GRC IMC EMT RNC, Type EPC-40-PVC.

3. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC, direct buried concrete encased.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway Plenum-type, communications-cable pathway EMT.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway Riser-type, communications-cable pathway EMT.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway Plenum-type, optical-fiber-cable pathway Plenum-type, communications-cable pathway EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use set-screw or compression, fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways where they indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C) Insert temperature.

3.03 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA/BICSI 568.
   3. TIA-569-D.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270530 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

F. Complete pathway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Route exposed conduits parallel and perpendicular to walls.

K. Route conduits installed above accessible ceilings parallel and perpendicular to walls.

L. Cut conduit square using saw or pipe cutter. De-burr cut ends of conduits.

M. Provide insulated bushings on conduit ends.

N. Install fittings to accommodate expansion and deflection where conduits cross seismic, control and expansion joints.

O. Do not flexible conduits unless identified on the Drawings or identified herein.

P. Provide pull boxes where the length of conduit exceeds 100 feet, or the conduit run contains the equivalent of more than 180-degrees of bends, and as shown on the Drawings. Locate pull boxes in straight runs only. Do not use pull boxes in lieu of a conduit bend. Locate pull boxes to allow clearance/access for the installation of the cable routed within. Where pull box will be located above inaccessible ceilings, notify Architect and coordinate requirements for an access panel to be installed to allow access to the pull box. Where a pull box cannot be installed upsize the conduit one trade size for every additional bend or every additional 25 feet of run.

Q. Support conduits on a maximum interval of 96 inches.

R. Support conduits within 12 inches of changes in direction.

S. Support conduit within 12 inches (300 mm) of pull box or enclosures to which attached.

T. Where communications cable pass through full height wall, provide,, 4 inch conduit sleeves in the wall to support the installation of communication cables.

U. Where cable tray installed as part of the 27 05 28 Work passes through a full height wall, provide conduit sleeves in the wall equal to 125% of the volumetric equivalency of the cable tray.

V. Where communications cable pass through fire or smoke rated wall, provide 4 inch fire rated conduits/conduit sleeves in/thru walls to support the installation of communication cables.

W. Where non-fire rated conduits pass through fire or smoke rated wall and floors, provide a fire stopping system to re-rate the walls or floors.

X. Where communications cable pass from a room through full height walls in route to a communication room or cable tray, provide a 1 inch, 1 1/2 inch, 2 inch conduit sleeves in the walls to support the installation of communication cables.

Y. Where communications cable pass through fire or smoke rated walls, provide and affix adhesive wall label immediately adjacent to the cable pathway/device devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

Z. Where conduits smaller than 4 inches meet up with cable trays, secure the conduit to the cable tray so that cables can exit the conduit without exceeding the bend radius of the cables.

AA. Where 4-inch conduits meet up with cable trays, provide an 18 inch gap between the conduits and the cable trays.

BB. Where conduits and conduit sleeves pass through a wall in a corridor, extend the conduits a minimum of 18 inches from the wall.

CC. Where conduits and conduit sleeves pass through a fire rated floor, extend the conduits 3 inches above the finished floor. Fire stop around all conduit sleeves.

DD. Where conduits and sleeves pass through floors, extend the conduits in the ceiling below to a maximum height of 120 inches above the finished floor, or as shown on the Drawings. Fire stop around all conduit sleeves.

EE. Where conduits penetrate exterior membranes, walls, floors, ceilings or roofs, seal and grout conduits. Extend conduits into rated enclosure, rated pull box or goose neck exterior to the building. Coordinate method of sealing conduits and penetrations with the Architect.

FF. Provide pull cord in all conduits over 36 inches long. Leave a minimum of 12 inches of slack at each end of the pull cord. Attach and secure the pull cords to the conduits or back boxes.

GG. Paint exposed conduits to match the color of the wall or ceiling structure behind/above it. Coordinate paint color and method of application with the, Architect prior to commencement of Work.

HH. Maintain and repair fire-proofing material during the installation of conduits and supporting structure.

II. Coordinate the installation of concealed conduits, method of connection and exact location and routing with the Architect prior to commencement or Work.

JJ. Provide deflection couplers at expansion joints. Secure conduits to the slab, building on each side of an expansion joint.

KK. Provide pull boxes and flexible conduits at seismic joints. Secure pull boxes to the slab, building on each side of a seismic joint. Provide flexible conduits in between pull boxes.

LL. Do not daisy chain back boxes with a single conduit feed unless shown on the Drawings.

MM. In Communication Rooms.
1. Where conduits enter the room at a point above 12 feet above finished floor, bend the conduits down to a height of 120 inches above finished floor. Provide bushings on all conduits.
2. Where conduits enter the room at a point below 12 feet, provide cable spill ways on conduits.
3. Provide cable radius-control-module on square fire rated sleeves.
4. Bond the sleeves and conduits in the floors and walls of the communication rooms according to NFPA 70 and in compliance with Specification Section 27 05 26. Refer to Specification Section 27 05 26 for minimum bonding conductor sizing.
5. Seal empty conduits with a non-hardening re-enterable seal/ compound.

NN. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 2 inches (50 mm) concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

OO. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

PP. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

QQ. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

RR. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

SS. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

TT. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

UU. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
2. 1-Inch (25-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

VV. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel

box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

WW. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

XX. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

3.04 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete around conduit for a minimum of 12 inches (300 mm) on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.05 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.07 BACK BOXES - GENERAL

A. Provide back boxes at heights indicated on Drawings. If mounting heights are not shown, give priority to ADA requirements. Mount back boxes with height measured to center of box unless otherwise indicated.

B. Install individual back boxes. Do not gang back boxes together.

C. Recessed Boxes in Masonry Walls:
1. Saw-cut opening for back box in center of cell of masonry block and install back box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

D. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

E. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

F. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

G. Set metal floor boxes level and flush with finished floor surface.

H. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

I. Coordinate location of back boxes in masonry walls, glass walls and metallic walls with Architect prior to placement or cutting.

J. Secure back boxes to interior wall and partition studs. Position back boxes to allow for the thickness of the finish surface.

K. Provide back boxes with a minimum of 6-inch separation in non-acoustical rated walls. For acoustical rated walls, comply with Article “BACK BOXES - ACOUSTICAL REQUIREMENTS” in this Section.

L. Provide stamped steel bridges to fasten back boxes between studs.

M. Provide adjustable steel channel fasteners back boxes in accessible ceiling areas. Do not fasten back boxes to ceiling support wires or to piping systems.

N. When using T-bar back box hangar to support a communication system device, secure the hangar to structure above with a minimum 14 AWG wire.

3.08 BACK BOXES - ACOUSTICAL REQUIREMENTS

A. Offset back-to-back boxes a minimum distance of 18 inches for single stud walls and a minimum offset of 36 inches for double stud walls, with at least one stud between the boxes. Do not install back boxes back-to-back within one stud cavity.

B. Fill the cavity around boxes with fiberglass insulation.

C. Seal between boxes and wallboard with acoustical sealant.

D. Seal openings in boxes and backboxes with acoustical sealant.

E. For double stud walls, run wiring on the side of the wall that it serves. Locate junction boxes to combine wiring outside of double walls.

F. Notify the Architect of conflicts that result in unavoidable connection between the two wall frames of a double wall. Notification shall be prior to wall closure.

3.09 BACK BOXES IN FIRE RATED WALLS AND CEILING

A. Confirm aggregate penetrations of back boxes are a given area in fire rated walls and ceilings for all Specification sections do not exceed the allowable aggregate penetrations for s given area/wall and ceiling area as per the IBC 711.32, with the Architect.

B. Provide UL rated assemblies in fire rated assemblies.

3.10 BACK BOXES IN INACCESSIBLE CEILING ARES

A. Provide an individual conduit from each back box to an inaccessible ceiling area in the corridor. Indelibly mark the conduit with the Outlet ID as identified on the drawings or in the approved cable termination schedules as required by 27 15 00.

B. Where pull boxes are required in an inaccessible ceiling area, provide an access panel so that the bull box cover can be removed, and the pull box accessed.

3.11 BACK BOXES IN UN-INSULATED INTERIOR WALLS WITH ACCESSIBLE CEILINGS

A. Provide an individual conduit from each back box to an accessible ceiling area.

3.12 BACK BOXES IN UN-INSULATED INTERIOR WALLS WITH INACCESSIBLE CEILINGS, EXTERIOR WALLS OR INSULATED INTERIOR WALLS

A. Provide an individual conduit from each back box to an accessible ceiling area in adjacent rooms or corridors.

B. Install conduits and back boxes without damaging wall insulation or reducing its effectiveness.

C. Label conduits at the accessible ceiling area to show the back box. Refer to Architectural Drawings for workstation ID.

3.13 BACK BOXES FOR MILL WORK CONNECTIONS - WITH COLUMNS

A. Provide conduit(s) from the in-feed of the millwork raceway to an accessible ceiling area.

3.14 BACK BOXES FOR MILL WORK CONNECTIONS - FREESTANDING

A. Provide conduit(s) from the in-fed of the millwork raceway in slab turned up a nearby wall to an accessible ceiling space.

B. Label conduits at the nearby wall to show the back box. Refer to Architectural Drawings for workstation ID.

3.15 UNDER CARPET / IN CARPET RACEWAY

A. Provide under carpet/in carpet wireway in rooms and area as shown the Drawings.

B. Coordinate the installation of in wall infeed conduits with the infeed electrical conduits to ensure space and spacing prior to commencement of Work.

C. Coordinate exact position of the raceway and the connector receptacles in a room or space with the Architect prior to commencement of work.

D. Coordinate the installation of the raceways with the installation of the communications cables and audiovisual cables prior to commencement of Work.

E. Coordinate the installation of the raceways with the installation of the carpeting to ensure a tight coupling of wireway with the carpeting, prior to commencement of Work.

3.16 ABOVE FLOOR RACEWAY

A. Provide above floor raceway in rooms and area as shown the Drawings.

B. Coordinate the installation of in wall infeed conduits with the infeed electrical conduits to ensure space and spacing prior to commencement of Work.

C. Coordinate exact position of the raceway and the connector receptacles in a room or space with the Architect prior to commencement of work.

D. Coordinate the installation of the raceways with the installation of the communications cables and audiovisual cables prior to commencement of Work.

E. Coordinate the installation of the raceways with the installation of the carpeting to ensure a tight coupling of wireway with the carpeting, prior to commencement of Work.

3.17 FLOOR BOXES

A. Provide individual conduits from each floor box or poke through device location to an accessible ceiling area. When the conduit is run in the ceiling of the floor below, stub the conduit up to the same floor as the communication outlet through a wall as shown on the Drawings. When the conduit is run in the floor slab, stub the conduit up the wall in proximity as the nearest cable tray as shown on the Drawings.

B. Label conduits at the accessible ceiling area to show the workstation location. Refer to Architectural Drawings for workstation ID.

3.18 FLOOR BOXES IN SLAB ON GRADE

A. Provide individual conduits from each floor box to a consolidation point location interior to the building within 25 feet of the point where the conduit exits the slab.

B. Label conduits at the accessible ceiling area to show the floor box location. Refer to Architectural Drawings for workstation ID.

3.19 CONDUIT SIZING TABLE

A. Provide conduits to back boxes for communication outlets to accessible ceiling areas sized as per the following.

Conduit Size (inches)

Wall Outlets (Except Wall Phones)	1
Wall Phone	3/4
Video Display Outlet	1-1/2

Wireless Access Point Outlet	1
Audio Speaker	3/4
Media Link Controller	1-1/4
Media Source Input Plate	1-1/4
Media Source Switcher	1-1/4
Intercom Station	1
Audiovisual (AV) System Outlet	1-1/4
Video Surveillance Camera Outlet	1
Multiple Gang Recessed Floor Box Outlet (Network)	1-1/4
Multiple Gang Recessed Floor Box Outlet (Network & AV)	1-1/4 & 1-1/2
Millwork - Per Every (2) Workstations	1
Millwork - Per Every (3) Workstations	1-1/4
Surface Metal Raceway - Per 8 Liner Feet of SMR	1

3.20 PULL BOX SIZING TABLE

A. Provide pull boxes based on the following table.

Pull Box Sizing (inches

Conduit Trade Size	Width	Length	Depth	Increase Width For Additional Conduits
1 or less	4	16	3	2
1 1/4	6	20	3	3
1 1/2	8	27	4	4
2	8	36	4	5
2-1/2	10	42	5	6
3	12	48	5	6
3-1/2	12	54	6	6
4	15	60	8	8

3.21 CONDUIT BENDS

A. Provide bends in the conduits based on the following chart:

Minimum Radius (inches)

Sizes of Con-duit Trade Size	Radius of Conduit Bends
3/4	6
1	6
1-1/4	7-1/5
1-1/2	9
2	12
2-1/2	25
3	30
3-1/2	36h
4	40

3.22 EXPANSION/DEFLECTION FITTINGS

A. Provide expansion fittings where conduits cross building or structure expansion joints.

B. Provide expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Provide conduit supports to allow for expansion movement.

C. Arrange pathways to cross building expansion joints at right angles with expansion fittings.

D. Provide fittings to match the type of conduit installed.

E. Provide in conduits run aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). I

F. Provide in conduits run aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).

G. Provide type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   1. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   2. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   3. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

H. Provide fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

3.23 PULL CORDS

A. Provide a nylon, polypropylene or monofilament plastic pull cord with not less than 200-lb (90-kg) tensile strength, in conduits.

B. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

3.24 FIRESTOPPING

A. Provide firestopping systems at rated walls and floors.

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

C. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

E. Provide labels on each side of walls immediately adjacent to wall firestopping devices identifying the manufacturer, fire-stopping system and associated UL system description/number of the device used to re-rate the wall or floor.

F. Provide labels on the wall immediately adjacent to a floor firestopping device identifying the manufacturer, fire-stopping system and associated UL system description /number of the device used to re-rate the wall or floor.

3.25 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

3.26 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 05 30 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes proving materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of a hanger and support for communications system.

1.02 RELATED SECTIONS

A. Section 26 05 36 Cable Trays for Electrical Systems.

B. Section 27 05 26 Grounding ad Bonding for Communication Systems.

1.03 REFERENCES

A. ASTM A123 (ASTM International) - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.

B. ASTM A510 (ASTM International) - Specification for General Requirements for Wire Rods and Coarse Round Wire, carbon Steel.

C. ASTM A525 (ASTM International) - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process.

D. ASTM A 580, - Standard Specification for Stainless Steel Wire.

E. ASTM A 591, - Specifications for Electrodepositing Coatings of Zinc on steel wire or sheets.

F. ASTM B633 (ASTM International) - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

G. ASTM A 641, - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.

H. ASTM D3451, - Standard Guide for Testing Coating Powders and Powder Coatings.

I. NEMA FG-1 (National Electrical Manufacturers Association) - Fiberglass Cable Tray Systems.

J. NEMA VE-1 (National Electrical Manufacturers Association) - Metallic Cable Tray Systems.

K. NEMA VE-2 (National Electrical Manufacturers Association) - Metallic Cable Tray Installation Guidelines.

1.04 ACTION SUBMITTALS

A. Product Data
   1. Materials list.
   2. Technical data (cut sheets) for on each component.

B. Shop Drawings:
   1. Accessories and fittings.
   2. Dimensioned drawings.
   3. Lifting and support points.
   4. Installation drawings showing sizes of items, weights, and support points.
   5. Installation plan and schedule.
   6. Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Locations where clearances cannot be maintained.
      d. Interface points for conduits through fire rated walls.
      e. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      f. Connections to seismic restraints.
      g. Grounding methods of connection.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

D. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents:
   1. Record actual routing of cable tray and main runs of J Hooks and locations of supports.
   2. Identify locations where firestopping system have been applied.

B. Visual inspection reports.

C. Test results.

1.06 COORDINATION

A. Coordinate the installation of cable trays outside of the communication rooms with the Work of other Divisions.

B. Coordinate the installation of cable trays inside the communication rooms with the Section 27 11 00 Work. Provide information for the completion of Section 27 11 00 Shop Drawings.

C. Coordinate the bonding of cable trays with the bonding busbars installed under Sections 26 05 26 and 27 05 26.

D. Coordinate requirements for seismic bracing of components with the Architect.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
   2. Flame Rating: Class 1.
   3. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) on-center in at least one surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit; Atkore International.
      b. CADDY; brand of nVent Electrical plc.
      c. Cooper B-line; brand of Eaton, Electrical Sector.
      d. G-Strut.
   2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   3. Material for Channel, Fittings, and Accessories: Galvanized steel.

4. Channel Width: Determined based on field conditions
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
7. Channel Dimensions: Selected for applicable load criteria.

B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) on-centerin at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Industries, Inc.
   b. Flex-Strut Inc.
   c. Unistrut; Atkore International.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Material: 6063-T6 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
5. Channel Width: Selected for applicable load criteria 1-5/8 inches (41.25 mm) 1-1/4 inches (31.75 mm) 13/16 inches (20.64 mm).
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel for use in hardened Portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-line; brand of Eaton, Electrical Sector.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti, Inc.
      4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M,Grade A325 (Grade A325M).
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.03 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

2.04 WIDE BASE CABLE SUPPORTS

A. Manufacturers:
   1. ERICO/Caddy
   2. Garvin
   3. ICC
   4. Panduit (J-Pro)
   5. Platinum Tools (MPH)
   6. MonoSystems

B. UL listed.

C. ANSI/TIA compliant for cable radius standards.

D. J-Hooks with wide base and flared/beveled edges, snap in latch gates/cable retainers and supporting structure. Complete with brackets, fasteners, clamps, C and Z Purlins,

hanger rods or support wires for attaching, securing and connecting to walls, slabs, beams and ceiling structures.

1. Color:
   a. White – Standard Cabling
   b. Green – Wireless Cabling
   c. Black – Security Cabling
2. Suitable for use in a plenum environment.
3. Size: 1”, 2” and 4”.
4. Finish:
5. Dry Locations - Galvanized.
6. Wet/Damp Locations - Stainless steel.

2.05 METAL WIRE MESH WITH SIDE WALLS CABLE TRAY

A. Manufacturers:
   1. B-Line.
   2. Chatsworth Products Inc.
   3. Cablofil.
   4. Cablobend
   5. Cope.
   6. Globetray.
   7. Hubbell.
   8. Husky.
   9. Siemon Company.
   10. Snake tray.
   11. T & B.
   12. Wire maid.

B. UL Classified.

C. Product Description: NEMA VE-1, Class 6A welded steel wire mesh segmented construction cable tray.

D. Finish: ASTM B633, SC2 galvanized.

E. Finish: ASTM A580 Type 304L, stainless steel.

F. Inside Width: As shown on Drawings.

G. Inside Depth: As shown on Drawings.

H. Material: ASTM A510 wire, .216-inch diameter flat/shaped cross-wires.

I. Complete with supports, no-splice supports, clamps, hangers, brackets, pre-formed bends, pre-formed tees, pre-formed intersections, pre-formed reducers, splice plates/bars, radius corner splices, vertical transitions, blind ends, barrier strip/dividers, steel flame retardant flat bottom liners/inserts, liners/inserts with side walls, covers,

connectors, bottom (perpendicular) cable drop outs, end/side wall (parallel) radius wall fall drop outs, grounding straps and associated nuts, bolts and washers.

2.06 METAL FLAT LADDER TYPE CABLE TRAY / CABLE RUNWAY

A. Manufacturers:
1. B-Line.
2. Chatsworth Products Inc.
3. Husky.
4. Hubbell.
5. Snake Tray.

B. UL Classified.

C. Product Description: NEMA VE-1, Class 20C, Constructed of, .375” x 1.5” rails and .065” thick rungs, rectangular steel tubing.

D. Finish: ASTM A525, mill galvanized before fabrication.

E. Inside Width: As shown on the Drawings.

F. Rung Spacing: 9 inches on center.

G. Rungs width: 1” minimum.

H. Complete with, radius (perpendicular) drop out guides (waterfalls), side wall (parallel) drop outs, heavy duty butt splice kits, heavy duty junction splice kits, tray corner brackets, equipment-rack-to-tray mounting kits, end feet, vertical wall brackets, cable retaining posts, protective end caps, grounding straps and associated nuts, bolts and washers.

2.07 METAL LADDER-TYPE WITH SIDE WALLS CABLE TRAY

A. Manufacturers:
1. B-Line.
2. Cope.
3. Globetray.
4. Husky.

B. UL Classified.

C. Product Description: NEMA VE-1, Class 12A ladder type tray.

D. Material: Aluminum.

E. Finish: ASTM A525, mill galvanized before fabrication.

F. Inside Width: As indicated.

D. Confirm that at locations where cable trays pass through walls, the wall penetrations have a framed opening to allow the cable tray to pass through and to allow the installation of:
   1. Fire stopping materials as an approved fire stopping system.
   2. Sound absorptive materials as an approved sound stopping system.

E. Coordinate non-compliant locations with the Architect for corrective action.

F. Install seismic restraints in accordance with Section 27 05 00 and 26 05 00.

G. Coordinate the installation of the cable trays with the installation of architectural, structural, lighting, power, mechanical and fire protection system components.

H. Utilize factory made preformed fittings (tee, cross, reducers, and 90-degree turns).

I. Maintain access clearance to cable trays, minimum of 18-inches above, 12-inches below, and 18-inches on at least one side every 6-feet. Provide 9-inches clearance between the cable tray and parallel walls. Provide 6-inches clearance between the cable tray and light fixtures.
   1. At areas where clearance above the cable tray may not be maintained:
   2. Transition the cable tray section to a wider but shallower cable tray section.
   3. Transition the cable tray to conduit.

J. Coordinate alternative solutions with the Architect.
   1. Install cable trays so that cables installed within the cable tray are separated from sources of electromagnetic interference by a minimum of the following.
   2. Open power conductors less than 2 kVa: 5-inches.
   3. Open power conductors less than 5 kVa: 12-inches.
   4. Open power conductors greater than 5 kVa: 24-inches.
   5. Electrical motors and transformers: 48-inches.
   6. Light fixture ballast: 5-inches.

K. Provide off-sets to avoid conflicts with other ceiling elements. Notify Architect of conflicts that cannot resolved by the installation off off-sets.

L. Provide cable tray with side walls in the open areas as shown on the Drawings. Mount bottom of cable trays overhead at approximately 6-inches above suspended ceilings unless otherwise shown on Drawings.
   1. Provide splice-kits where cable tray lengths require the joining of two sections, tee fittings, and reducers.
   2. Provide threaded-rod-ceiling-kits.
   3. Ground each cable tray section to the next and to approved grounding points.
   4. Provide accessories and special transitions with 12” minimum radius turns for all changes in direction and offsets. Use manufacturers standard fittings including bolting assemblies for all end-to-end connections.
   5. Provided drop outs where cables transition down to other infrastructure components.

G. Inside Depth: As indicated.

H. Straight Section Rung Spacing: 6 inches on center.

I. Inside Radius of Fittings: As indicated on Drawings.

J. Complete with clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.08 WARNING SIGNS

A. Engraved Nameplates: 1” black letters on yellow laminated plastic nameplate, engraved with the following wording:

WARNING! DO NOT USE CABLE TRAY AS A WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES!

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing components and systems. Where no instructions are included with the equipment, follow accepted industry best practices as identified in the BICSI Design and Installation Manual.

B. Verify the routing of cable tray prior to rough-in. Report space or access conflicts to the Architect.

C. Refer to Architectural drawings for ceiling construction and fire rated wall/floors construction locations and details.

3.02 INSTALLATION

A. Install cable tray in accordance with NEMA VE-1 and NEMA VE-2 requirements.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work. Where a remedy of unsatisfactory conditions is not available or possible, notify the Architect for resolution.

6. Provide interior surfaces which are smooth and free of offset edges, projections or misalignment. Assembly bolts for end-to-end connections shall have a pattern, which does not cause any damage to cable sheaths of jackets. All edges smooth, de-burred.
7. Support cable tray within 24-inches of cable tray section splices or intersections. Support intersections on all sides. Support cable tray on both sides of every change in elevation/direction. The weight of the load on the cable tray shall not exceed the stated limits per span in the manufacturer's published load table. Use additional supports where needed.
8. At a minimum, brace cable tray to structure with diagonal braces spaced 30-feet maximum on center.
9. Install expansion connectors where cable tray crosses a building expansion joint. Space connectors and set gaps according to NEMA VA 1.

M. Provide cable runway type trays in the communication rooms as shown on the Drawings.
1. Mount cable trays overhead at or as at the shown height on the Drawings.
2. Provide vertical sections mounted to the wall from the horizontal cable runway sections:
   a. To sleeves in the wall when the sleeves are greater than 30-inches away from the horizontal sections of cable runway.
   b. To conduit sleeves in the floor.
   c. To conduit sleeves in the slab above when the conduit sleeves are greater than 30-inches away from the horizontal sections of cable runway.
3. Install cable runways with the rungs facing down.
4. Provide radius drop out guides above the vertical cable managers installed on the sides of equipment racks.
5. Provide radius dropouts above the cable entrance ports in the top panels of equipment cabinets. Note that equipment cabinets have multiple cable entrance ports.
6. Provide splice-kits where cable tray lengths require the joining of two sections.
7. Provide cable retaining posts on each of the cable tray at 18-inch intervals.
8. Provide threaded-rod-ceiling-kits spaced 60-inches on center, within 24 inches of a splice to support the cable tray overhead.
9. Provide end-foot-kits and brackets to support the cable tray where it meets a wall.
10. Provide caps on exposed cable runways ends.
11. Provide caps on exposed threaded rod ends.
12. Ground each cable tray section to the next. Ground cable tray to the nearest grounding busbar located within the respective room.
13. Do not install triangle support wall brackets to support cable runway sections.

N. When cables are installed outside of conduits and are not supported by cable tray, provide the J- hooks to support cables.
1. 1-inch-wide J-hook for up to 10 cables.
2. 2-inch-wide J-hook for up to 24 cables.
3. 3-inch-wide J-hook for up to 48 cables.
4. 4-inch-wide J-hook for up to 72 cables.

O. Provide multiple J-hooks in a run of cables where cable count limits are exceeded or as per cable segregation requirements identified here-in.

P. Provide applicable accessories to independently support J-hooks from structure, including extender bracket/trees for mounting multiple J hooks on a single support, fasteners, and clamps for connecting to wall, beams, rods, dedicated support wires and C and Z Purlins as required for specific construction.

Q. Space cable supports and J-hooks at a maximum of 48-inch intervals and at each change of direction of the cables. Maintain a maximum of 12-inch sag in the cable between supports. Provide additional J-hooks when interval and or sag limits are exceeded.

R. At a minimum, brace multiple J-hook assemblies from structure with diagonal braces at each change of direction of the cable run.

S. Use installation tools and practices recommended by the manufacturer to field modify wire mesh cable tray intersections and changes in elevation.

T. Install firestopping in accordance with Section 27 05 28 to sustain ratings when passing cable tray through rated elements.

U. Maintain and repair fire-proofing material during the installation of cable tray and cable supporting structure.

V. Install warning signs at 20 feet centers along cable tray where the cable tray is open to the space above, located to be visible location.

W. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

X. Comply with requirements for pathways specified in Section 270528 "Conduits and Back Boxes for Communications Systems."

Y. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

Z. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps or single-bolt conduit clamps, using spring friction action for retention in support channel.

3.03 SUPPORT INSTALLATION

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Use expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps.
7. To Light Steel: Sheet metal screws.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.04 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

3.05 CABLE TRAY GROUNDING

A. Bond the cable trays according to NFPA 70 and in compliance with Section 27 05 26. Refer to Section 27 05 26 for minimum bonding conductor sizing.

B. Thoroughly clean surfaces receiving connections for bonding.

C. Remove paint from painted metal components where bonding/ground lugs contact metallic components.

D. Apply antioxidant joint compound where metallic components contact bonding/ground lugs.

E. Bond cable tray section with splice plates or jumpers listed for grounding purposes.

3.06 FIELD QUALITY CONTROL

A. After installing cable trays and before cables have been energized, inspect for compliance with requirements.
   1. Inspect cable insulation for damage. Correct sharp corners and protuberances in cable tray. Eliminate causes of vibration and thermal expansion/contraction which may cause or have caused damage.
   2. Verify the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
   3. Verify there is no intrusion of such items as pipe, hangers or other equipment that could damage cables.
   4. Inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
   5. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   6. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Testing
   1. Test cable tray systems in accordance with NFPA 70B Chapter 21 for electrical continuity and connection to approved ground.
   2. Prepare and submit report of findings of visual inspections under Article “Closeout Submittals.

3.07 FIRESTOPPING

A. Provide firestopping systems at rated walls and floors.

B. [Comply with requirements in Section 07 84 13 "Penetration Firestopping".]

C. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

END OF SECTION

SECTION 27 05 43 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes furnishing materials, equipment, labor, supervision, tools, and items necessary for the construction and installation of an underground ducts and conduits for communication systems.

1.02 RELATED DOCUMENTS

A. BICSI Telecommunications Distribution Methods Manual (TDMM), Fourteenth Edition.

B. Section 26 05 45 - Underground Duct and Vaults

C. Section 27 05 28 - “Conduit Back Boxes for Communications Systems.”

1.03 SUMMARY

A. Section Includes:
   1. Metal conduit and fittings, including GRC and PVC-coated GRC.
   2. Utility structure accessories.

1.04 REFERENCES

A. ANSI C80.1 (American Society for Testing and Materials) - Rigid Steel Conduit, Zinc Coated.

B. ANSI/SCTE 77 (Society of Cable Telecommunication Engineers) Underground Enclosure Integrity.

C. ASTM A48 (American Society for Testing and Materials) - Gray Iron Castings.

D. ASTM C857 (American Society for Testing and Materials) - Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

E. ASTM C858 (American Society for Testing and Materials) - Underground Precast Concrete Utility Structures.

F. ASTM C891 (American Society for Testing and Materials) - Installation of Underground Precast Utility Structures.

G. ASTM C1037 (American Society for Testing and Materials) - Inspection of Underground Precast Utility Structures.

H. ASTM F512 (American Society for Testing and Materials) - Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.

I. IEEE C2 (Institute of Electrical and Electronic Engineers) - National Electrical Safety Code.

J. NEMA FB 1 (National Electrical Manufactures Association) - Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable.

K. NEMA TC 2 (National Electrical Manufactures Association) - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.

L. NEMA TC 3 (National Electrical Manufactures Association) - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

M. UL 514B (Underwriters Laboratories, Inc.) - Conduit, Tubing and Cable Fittings.

N. UL 651 (Underwriters Laboratories, Inc.) - Schedule 40 and 80 Rigid PVC Conduit and Fittings.

O. UL 651A (Underwriters Laboratories, Inc.) - Type EB and A PVC Conduit and HDPE Conduit.

1.05 DEFINITIONS

A. Controlled Density Fill (CDF): A low strength, flowable, self-consolidating, non-shrinking material.

B. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as controlled density fill or concrete.

C. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.

D. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

E. Duct Bank:
   1. Two or more ducts installed in parallel, with or without additional casing materials.
   2. Multiple duct banks.

F. GRC: Galvanized rigid conduit.

G. IMC: Intermediate metal conduit.

H. RNC: Rigid nonmetallic conduit.

I. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.06 ACTION SUBMITTALS

A. Product Data:
   1. Technical data (cut sheets) for on each component.
   2. Trench base, back fill and encasement data including percentage mix of each material in the fill and the maximum diameters of particulates.

B. Calculations:
   1. Concrete mix strengths and calculations.

C. Shop Drawings:
   1. Scaled site plans showing:
      a. Location and routing of ducts and conduits.
      b. Conduit bend angles and radii.
      c. Transition points from one conduit material to another.
      d. Utility vaults and hand-holes.
      e. Means of utility vault and hand-hole drainage.
      f. Duct and conduit attachment points to existing structure and utility poles and new structures and utility poles.
      g. Duct and trench profiles and elevations.
   2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
      a. Dimensioned plans, sections, and elevations, and fabrication and installation details.
      b. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
      c. Duct entry provisions, including location and duct size.
      d. Collars and cover.
      e. Grounding details.
   3. Manufacturer's Quality Control Reports: For precast structures, submit production quality control reports.
      a. Test procedures used.
      b. Test results that comply with requirements

1.07 INFORMATIONAL SUBMITTALS

A. Product Certificates: For concrete and steel used in precast concrete vaults and handholes, as required by ASTM C858.

1.08 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of utility vaults and hand-holes.

B. Report of mandrel test results of duct integrity.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Accept utility vaults and hand-holes on site. Inspect for damage.

B. Move and store in compliance with manufacturer’s instructions.

C. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

D. Arrange so identification markings are visible.

1.10 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.11 FIELD CONDITIONS

A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of communications service.
   2. Do not proceed with interruption of communications service without Owner's written permission.

B. Ground Water: Coordinate ground level with civil engineer

1.12 COORDINATION

A. Coordinate the installation of conduit, utility vaults and hand-holes with the Work of Division 26 and 33.

B. Coordinate the installation of conduit, utility vaults and hand-holes with the existing underground utilities and structures.

C. Coordinate the installation of conduit, utility vaults and hand-holes with Telecommunication Service Providers existing and proposed underground and aerial facilities and structures.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. PVC-Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
2. AFC Cable Systems; Atkore International.
3. Allied Tube & Conduit; Atkore International.
4. Anaconda Sealtite; Anamet Electrical, Inc.
5. Calconduit; Atkore International.
6. Champion Fiberglass, Inc.
7. Electri-Flex Company.
8. FSR Inc.

D. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

2.02 RIGID NONMETALLIC CONDUITS

A. Underground Plastic Conduits: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex Inc.
4. CertainTeed LLC; Saint-Gobain North America.
5. Champion Fiberglass, Inc.
6. Condux International, Inc.
7. Crown Line Plastics.
8. ElecSys, Inc.

C. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

D. Solvents and Adhesives: As recommended by manufacturer.

TABLE 1 Vehicle and Pedestrian Load Designations

Designations	Maximum Loads	Uses
A-16 (HS20-44)[A]	16 000 lbf (71 172 N)/wheel	heavy traffic
A-12 (HS15-44)[A]	12 000 lbf (53 376 N)/wheel	medium traffic
A-8 (H10-44)[A]	8 000 lbf (35 586 N)/wheel	light traffic
A-0.3	300 lbf/ft^2(14.4 kPa)	walkways[B]

[A]The designations in parentheses are the corresponding AASHTO designations.
[B]Anticipated designs other than those listed should be designated by purchaser.

E. HDPE Conduit: Type EPEC 40-HDPE and Type EPEC 80-HDPE complying with NEMA TC 7 and UL 651A.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB, Electrification Business.
      b. ARNCO Corp.
      c. National Pipe & Plastics.
      d. Opti-Com Manufacturing Network, Inc (OMNI).
      e. Premier Conduit.
   2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
   3. Comply with TIA-569-C and TIA-758-C.

2.03 CONDUIT ACCESSORIES

A. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal pull tape/cord and tracer wire.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Maxcell.

B. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB, Electrification Business.
      b. Allied Tube & Conduit; Atkore International.
      c. Cantex Inc.
      d. IPEX USA LLC.

C. Underground-Line Warning Tape: Underground-line orange warning tape.

2.04 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of vaults and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing components, assembles and structure. Where no instructions are included with the equipment, follow accepted industry best practices as identified in the BICSI Outside Plant Design Reference Manual.

B. Comply with utility vault and hand hole manufacturer's instructions for lifting, moving, site preparation, excavation, and bedding

C. Keep items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures throughout the life of the project.

D. Maintain safe ingress and egress from work areas during the movement and installation of materials.

E. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work. Where a remedy of unsatisfactory conditions is not available or possible, notify the Architect for resolution. Do not proceed until unsatisfactory conditions have been corrected.

F. Install pull-tape in continuous lengths. Do not splice pull-tapes.

3.02 PREPARATION

A. Coordinate layout and installation of duct, duct bank, vaults, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into vaults, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and

elevations as required to suit field conditions and to ensure that duct runs drain to vaults and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing."

D. Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.03 EXISTING WORK

A. Maintain access to existing duct bank and other installations remaining active and requiring access.

3.04 DUCT APPLICATION

A. Duct for Communications: Type EPC-80-PVC, Type EPC-40-PVC, Type EB-20-PVC RNC, in concrete-encased duct bank unless otherwise indicated.

B. Duct for Communications: Type EPEC-40-HDPEor Type EPEC-80-HDPE duct in direct-bored duct bank unless otherwise indicated.

C. Underground Duct Crossing Paved Paths and Driveways: Type EPC-40-PVC RNC, encased in reinforced concrete.

3.05 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed or after construction in immediate area is complete.

C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.06 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.

C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward vaults and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two vaults, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm) 12.5 feet (4 m) 25 feet (7.5 m), both horizontally and vertically, at other locations unless otherwise indicated.
   1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.

E. Transition from schedule PVC conduits to rigid galvanized steel conduits minimum of 10 feet where:
   1. A duct or conduit enters a building wall or beyond shear point of foundation excavation.
   2. A duct or conduit enter a utility tunnel.
   3. A duct or conduit enters a shear point of foundation excavation.
   4. A duct or conduit has a bend radius of less than 8 feet.

F. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.

G. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

H. End-Bell Entrances to Vaults and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct slope and without forming a trap in the line.
   2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to vault or handhole. Install an

expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch (19 mm).

3. Grout end bells into structure walls from both sides to provide watertight entrances.

I. Terminator Entrances to Vaults and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to vault or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch (19 mm).

J. Where conduits enter a vault or hand-hole, connect the conduits as low as possible into the ends of the vault or hand-holes Provide duct plugs on all conduits to withstand at least 15-psig hydrostatic pressure.

K. Where conduits stub up alongside of a utility pole, into a light pole or its base, into a pedestal or into an enclosure mounted at the base of a light pole, coordinate the placement of the conduit with the structure serving the structures. Extend conduits a minimum of 12 inches above a structure and a minimum of 96 inches alongside a utility pole. Locate conduits at the curb side and down traffic side of utility poles alongside vehicular roadways.

L. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

M. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

N. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for duct less than 6 inches (150 mm) in nominal diameter.
2. Install duct with a minimum of 3 inches (75 mm) between duct for like services and 6 inches (150 mm) between power and signal duct.
3. Depth: Install top of duct or duct bank at least 36 inches (900 mm) below finished grade unless otherwise indicated.
4. Set elevation of bottom of duct or duct bank below frost line.
5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
7. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow. Extend encasement minimum of 36 inches (900 mm) beyond elbow joints.
8. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
    a. Couple GRC to duct with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
9. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
    a. Place minimum of 3 inches (75 mm) of sand as a bed for duct and duct bank. Place sand to a minimum of 6 inches (150 mm) above top level of duct and duct bank.
    b. Place minimum of 6 inches (150 mm) of engineered fill above concrete encasement of duct bank.

O. Underground-Line Warning Tape: Bury conducting underground-line warning tape no less than 12 inches (300 mm) above all concrete-encased duct and duct bank and approximately 12 inches (300 mm) below grade. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

P. INSTALLATION OF INNERDUCTS
1. Provide four 1-inch round, One, two or three 3-cell fabric innerducts in each 4-inch duct and conduit,.
2. When installing multi-cell packs in a single conduit/duct, provide a different color-coded thread to differentiate one pack from another.

3. Provide a pull-cord in each inner-duct. Provide at least ten feet extension beyond each utility vault, hand-hole utility tunnel or building entrance. Securely tie innerducts end to support hardware at each at each end.

3.07 IDENTIFICATION

A. Identify ducts and conduits with numerically stamped stainless steel tags permanently attached to the inside of vaults adjacent to each duct entrance. Coordinate nomenclature of the identification numbers with the Architect, Owner.

3.08 GROUNDING

A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.09 FIELD QUALITY CONTROL

A. Test and inspect precast concrete utility vaults and hand-holes in according to ASTM C 1037.

B. Perform the following tests and inspections and prepare test reports:
1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-(300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
3. Test vault and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."

C. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.

B. Clean internal surfaces of vaults, including sump.
1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION

SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes materials, equipment, labor, supervision, tools and items necessary for the installation of identification labels for communication components, devices and cables.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. BICSI Telecommunications Distribution Methods Manual (TDMM), Fourteenth Edition.

C. Section 27 05 28 - “Pathways for Communications Systems.”

D. Section 27 11 00 - “Communication equipment room fittings”.

E. Section 27 13 00 - “Communications Backbone Cabling.”

F. Section 27 15 00 - “Communications Horizontal Cabling.”

1.03 REFERENCES

A. ANSI/TIA 606 Administrative Standard for Telecommunication Infrastructure

1.04 ACTION SUBMITTALS

A. Product Data:
1. Materials list.
2. Technical data (cut sheets) for each type of label.

B. Identification Schedule:
1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

1.05 COORDINATION

A. Coordinate the final labeling nomenclature for cables, and termination devices with the Owner and Architect prior to installation of cable and device labels. Obtain Owner sign off prior to commencement.

B. Coordinate the format and schema of the cable termination schedules with the Owner and Architect prior to preparation of the schedules. Obtain Owner sign off prior to use on cables and termination devices.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:
   1. Black letters on a white field.

2.03 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Champion America.
      c. Panduit Corp.
      d. Permanent, waterproof black ink marker recommended by tag manufacturer.
      e. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Brother International Corporation.

c. emedco.
d. Panduit Corp.

3. Minimum Nominal Size:
   a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
   b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
   c. As required by authorities having jurisdiction.

2.04 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Ideal Industries, Inc.

B. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

C. Color and Printing:
   1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
   2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".

2.05 SIGNS

A. Baked-Enamel Signs:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carlton Industries, LP.
      b. Champion America.
      c. emedco.
   2. Preprinted aluminum signs, high-intensity reflective, **punched** or drilled for fasteners, with colors, legend, and size required for application.
   3. 1/4-inch (6.4-mm) grommets in corners for mounting.
   4. Nominal Size: 7 by 10 inches (180 by 250 mm).

B. Laminated-Acrylic or Melamine-Plastic Signs:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. emedco.

d. Marking Services, Inc.

2. Engraved legend.
3. Thickness:
   a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
   b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
   c. Engraved legend with black letters on white face.
   d. Punched or drilled for mechanical fasteners with 1/4-inch (6.4-mm) grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION

A. Provide identification labels that are in accordance with the approved cable termination schedule.

B. Room numbers shown on the Drawings may not the final room numbers. Validate the final room numbers with the Architect prior to use in creating termination schedules, cable identification labels, cable record drawings, O&M documentation, and cable test reports.

C. Provide machine-generated labels on cables in black uppercase lettering on a permanent adhesive, white label stock, covered with a permanent water-resistant sealer. Place labels on both ends of each cable and no more than 6 inches from the point at which the cable is broken out into individual copper pairs or strands from the connector or termination block or patch panel. Install labels so that the labels are parallel with the

cable. Install labels so that labels are readily visible. Do not label cables with hand lettered labels.

D. Provide machine-generated labels on termination block with the cable ID and cable pair in uppercase lettering. Do not label devices with hand lettered labels.

E. Provide machine-generated labels on splice panel with the equipment rack or equipment cabinet ID and the rack unit position in uppercase lettering. Do not label devices with hand lettered labels.

F. Provide machine-generated labels on patch panel, with the cable ID and port number in uppercase lettering. Do not label devices with hand lettered labels.

G. Replace labels if at any time during the project, the label becomes illegible or is removed.

H. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

I. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

J. Install identifying devices before installing acoustical ceilings and similar concealment.

K. Verify identity of each item before installing identification products.

L. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

M. Apply identification devices to surfaces that require finish after completing finish work.

N. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

O. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

P. Vinyl Wraparound Labels:
   1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
   2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
   3. Provide label 6 inches (150 mm) from cable end.

Q. Snap-Around Labels:
1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches (150 mm) from cable end.

R. Self-Adhesive Wraparound Labels:
1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches (150 mm) from cable end.

S. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

T. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

U. Underground-Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope **exceeds** 16 inches (400 mm) overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Cable Ties: General purpose, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.03 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
1. System legends shall be as follows:
a. Standard Data
b. Wireless
c. Security

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
   1. Standard Data = “IDF”-D-”Number” (White Jacks)
   2. Wireless = “IDF”-AP-”Number” (Green Jacks)
   3. Security = “IDF”-SC-”Number” (Black Jacks)

E. Equipment Room Labeling:
   1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
   2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels. Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
   3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
      a. Standard Data = “IDF”-D-”Number” (White Jacks)
      b. Wireless = “IDF”-AP-”Number” (Green Jacks)
      c. Security = “IDF”-SC-”Number” (Black Jacks)

F. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
   1. Standard Data = “IDF”-D-”Number” (White Jacks)
   2. Wireless = “IDF”-AP-”Number” (Green Jacks)
   3. Security = “IDF”-SC-”Number” (Black Jacks)

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.
   1. Apply to exterior of door, cover, or other access.

J. Equipment Identification Labels:
   1. Indoor Equipment: Self-adhesive label, Baked-enamel signs, Laminated-acrylic or melamine-plastic sign.
   2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign, Stenciled legend 4 inches (100 mm) high.
   3. Equipment to Be Labeled:
      a. Communications cabinets.
      b. Uninterruptible power supplies.
      c. Computer room air conditioners.
      d. Fire-alarm and suppression equipment.
      e. Egress points.

f. Power distribution components.

END OF SECTION

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes materials, equipment, labor, supervision, tools and items necessary for the construction and installation of communication equipment room fittings.

1.02 RELATED SECTIONS

A. Section 27 05 26 - Grounding and Bonding for Communication Systems.

B. Section 27 05 36 – Hangars and Supports for Communications Systems" for cable trays and accessories.

1.03 ACTION SUBMITTALS

A. Product Data:
   1. Materials list.
   2. Technical data (cut sheets) for on each component, including finishes and weights.

B. Calculations.

C. Requirements for device network switch port access.

D. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
   1. Details of seismic strengthening of components and equipment rack and cabinets
   2. Enlarged plans of communication rooms as they are framed and constructed. Indicate ancillary items on floor, walls, and ceiling inside the room. Indicate locations, size, weight and mounting height for bonding bars, equipment racks and cabinets, conduits, sleeves, cable trays and wall mounted enclosures, panels and termination devices to be installed in the communication rooms provided under the related Division 23, 26, 27 and 28 Work.
   3. Enlarged elevations for communication rooms. Indicate equipment racks and cabinets and wall mounted equipment to be installed in the communication rooms provided under related Division 26, 27 and 28 Work.

E. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.

Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Product information
2. Record actual location, size, dimension, height of the following.
a. Equipment racks and cabinets.
b. Plywood.
c. Vertical cable trays.
d. Horizontal cable trays.
e. Vertical conduits.
f. Horizontal conduits and sleeves.
g. Elevations of equipment, devices and receptacles mounted in the equipment racks and cabinets, noting the rack unit numbers.
h. Elevations of equipment, devices and receptacles mounted on the walls.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Technician Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.07 COORDINATION

A. Coordinate the Work of Division 23, Division 26, Division 27 and Division 28 Work components and cable to be installed in communication rooms.

B. Validate specific dimensions of all equipment being installed in the communication equipment rooms. Use specific dimension in the preparation of the coordinated Shop Drawings.

C. Coordinate layout and installation of communications equipment with Owner's telecommunications and systems Contractors and Vendors.

D. Coordinate service entrance arrangement with various Telecommunication Service Providers.

E. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives and Owner to exchange information and agree on details of equipment arrangements and installation interfaces. Record agreements reached in meetings and distribute them to meeting participants and the Architect

F. Coordinate the bonding of equipment racks and cabinets with the bonding busbars installed under Sections 26 05 26 and 27 05 26.

G. Coordinate the nomenclature and schema of identification labels for the equipment cabinets and racks with the Owner.

H. Coordinate the installation of networked devices with the Owner and their network engineers for network port access, provisioning, and IP network address requirements.

1.08 PRE-INSTALLATION CONFERENCE

A. Convene minimum 7 days prior to commencing work of this Section to include the Owner, Architect, Engineer, and the Division 23, 26, 27 & 28 installers. Validate field conditions, equipment dimensions, and spaces allocated for the installation of all equipment in the rooms.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.02 PLYWOOD BACKBOARDS

A. Void free, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).

2.03 BOXES AND ENCLOSURES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB, Electrification Business.
   2. Adalet.
   3. Crouse-Hinds; brand of Eaton, Electrical Sector.
   4. FSR Inc.
   5. Hoffman; brand of nVent Electrical plc.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Plastic or Fiberglass.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.04 FREE STANDING EQUIPMENT RACKS

A. Description: Two- and four- post racks with threaded rails designed for mounting network and communications equipment.
   1. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.
   2. Height / Rack Mount Unit (RU) - 84 inch / 45 RU, with RUs marked on the vertical rails.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Middle Atlantic
   2. Chatsworth Products Inc.

C. General Requirements:

1. Comply with UL2416.
2. 2-post equipment rack.
3. Rails: C shaped 3, inch channels with standard EIA-310-D hole spacing pattern.
4. Mounting holes: Tapped 12-24, both sides.
5. Heavy duty flanged base for floor mounting.
6. Top mounted jumper trough.
7. Punched to allow attachment of vertical cable managers along the sides or for rack-to-rack baying.
8. Finish: Manufacturer's standard, baked-polyester powder coat.
9. Color: Black.
10. Two-Post Load Rating: , 1,500 lb.
11. Four-Post Load Rating: , 1,500 lb.

D. Cable Management:
1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each equipment rack, with a minimum height of two rack units each.

2.05 EQUIPMENT RACKS & CABINETS ACCESSORIES

A. Manufacturers:
1. Chatsworth Products Inc.
2. Leviton

B. Environmental monitor with sensors
1. Mount: Horizontal with mounting hardware.
2. Operation: Set thresh holds for monitoring and alert notification.
3. Sensors: Temperature, humidity, dew point, air flow, water detection, door position, smoke sensors, analog dry contact.
4. Local LED display.
5. Web interface via Ethernet network connection.

2.06 CABLE MANAGEMENT

A. Manufacturers:
1. Chatsworth Products Inc.
2. Leviton

B. Vertical Cable Management:
1. double sided to match the height of the approved equipment rack with mounting hardware.
2. Plastic edge cabling guides. Openings shall align with Rack Mount Unit (RU) spacing.
3. Front and rear removable, reversible swing doors
4. Plastic materials meet UL 94V-O Resistant Standard.

5. Width: see drawings for size
6. Edge protected pass through ports between front and rear sections.
7. Cable tie down points along central divider.
8. Color to match equipment rack or cabinet.

2.07 EQUIPMENT RACK/CABINET-MOUNT BONDING BUSBAR

A. Manufacturers:
1. Chatsworth.
2. ERICO.
3. Cooper B-Line.
4. Hubbell.
5. Tyco Electronics / AMP NETCONNECT.

B. Horizontal Rack Bonding Busbar, UL Listed:
1. Material: Hard-drawn electrolytic tough pitch 110 alloy copper.
2. Size: Minimum of 3/16 inches thick and 3/4 inches high by 19 inches long for mounting on EIA standard equipment racks.
3. Attachment Points: Tapped ground mounting holes for the attachment of two hole grounding lugs.

C. Vertical Rack Bonding Busbar, UL Listed:
1. Material: Hard-drawn electrolytic tough pitch 110 alloy copper.
2. Size: Minimum of 3/16 inches thick and 3/4 inches high by 84 inches long for mounting on EIA standard equipment racks.
3. Attachment Points: Tapped ground mounting holes for the attachment of two hole grounding lugs.

2.08 CABLE TIES

A. Product Description:
1. Hook and Loop (i.e. Velcro™) style cable ties.

2.09 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers. Machine printed - self-adhesive and smudge resistant.

PART 3 - EXECUTION

3.01 GENERAL

A. Install equipment in the communications rooms as per the coordinated Shop Drawings.

B. Comply with manufacturers' instructions for installing components and adjusting equipment. Where no instructions are included with the equipment, follow accepted industry best practices as identified in the BICSI design and installation manual.

C. Provide equipment and component mounting hardware.

D. Keep items protected before and after installation, with dust and waterproof barrier materials. Maintain the integrity of the protective measures throughout the life of the project.

E. Do not install equipment in communications rooms until all wet work (i.e. painting, floor sealing, etc.) is complete.

F. Maintain safe ingress and egress from work areas during the movement and installation of materials.

G. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work. Where a remedy of unsatisfactory conditions is not available or possible, notify the Architect for resolution.

H. Clean up and remove all debris generated by installation activities. Keep the communication rooms free of debris always.

I. Deliver to Owner two sets of specialty tools specifically needed for proper operation, adjustment and maintenance of components installed under this Work.

J. Coordinate requirements for network switch ports and IP addresses with Owner to support the installation of components.

K. Coordinate layout and installation of equipment in the equipment racks and cabinets in the rooms. Coordinate service entrance configuration with service provider.
   1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

3.02 PLYWOOD BACKBOARDS

A. Comply with requirements for plywood backing panels specified in Division 06, [Section [06 10 00]] "Rough Carpentry

B. Provide plywood backboards in the communication room as shown on the Drawings. Install plywood 6 inches above finished floor with the top at 8 feet 6 inches above finished floor, unless otherwise noted. Paint the plywood backboards with fire retardant, non conductive, light colored semi-gloss paint with a patch of each sheet of plywood unpainted revealing the fire rating stamp.

C. Provide additional plywood backboards in the communication room in areas where cable runways are to be attached to walls and full sizes plywood are not required. Size plywood backboards to cover the attachment of the cable runways and extend to closest vertical wall stud.

D. Comply with requirements in Division 09, [Section [09 91 23]] "Interior Painting" for painting plywood backboards.

E. Paint plywood backboards prior to the installation of other Division 27 or Division 28 Work components or cable. Notify Architect if painting will occur after the commencement of the installation of components or cables for additional instructions.

3.03 EQUIPMENT RACKS/CABINETS

A. Install equipment racks and cabinets plumb and level.

B. Equipment Racks:
1. Provide equipment racks in the communication rooms as shown on the Drawings. Anchor equipment racks at 4 points to the floor as described below. Secure the top of equipment racks to the cable trays mounted above.
2. Secure the equipment racks to the overhead cable runway with standoff brackets.
3. Provide a vertical, grounding busbar each equipment rack according to the manufacturer’s installation instructions. Remove paint on each equipment rack to allow a good connection for grounding components. Clean the surface with an abrasive pad and apply antioxidant compounds between the rack and the busbar to prevent corrosion at the bond.
4. Provide vertical wire mangers in between the equipment racks and at the ends of the equipment rack rows as shown on the Drawings

C. Bonding:
1. Remove paint on the equipment rack and cabinet to allow a good connection for bonding components. Clean the surface with an abrasive pad and apply antioxidant joint compounds between the rack and the busbar to prevent corrosion at the bond.
2. Attach bonding busbars to the equipment racks and cabinets using 2-hole lugs according to the manufacturer’s installation instructions.
3. Bond the bonding busbars to the room bonding busbar with a bonding conductor sized at a minimum 6 AWG. Refer to Specification 27 05 26 for exact bonding conductor sizes.
4. Do not daisy chain the bonding of the equipment racks and cabinets with a common bonding conductor.

3.04 RACK ANCHORING

A. Provide anchoring suitable for installation in the seismic zone of the building. Confirm seismic zone classification with the Architect prior to commencement of anchoring.

B. Anchor equipment racks and cabinets in accordance with manufacturer instructions.

C. When equipment racks and cabinets are anchored to house-keeping pads, coordinate methodology of anchoring with the Architect and Structural Engineer.

D. Verify all slab depths prior to embedment of any anchor and ensure that no rebar or post tension cables will be compromised during installation of anchors.

E. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling.

F. Anchor 2-post equipment racks with 1/2-inch Hilti TZ Anchor Stainless Steel expansion anchors or equal embedded 2.5 inches at each corner.

G. Anchor 4-post equipment racks and equipment cabinets with 3/8-inch Hilti TZ Anchor Stainless Steel expansion anchors or equal embedded 2.5 inches at each corner.

H. When placed over a raised floor, pass the threaded rods through the raised floor tile to the structural floor below

3.05 IDENTIFICATION

A. Provide machine-generated identification labels on the top of equipment racks and cabinets that are in accordance with the approved Shop Drawings, both front and rear side of equipment racks and cabinets.

B. Provide machine-generated laminated labels, 3-inch wide, black uppercase lettering on a permanent adhesive, white label stock.

3.06 CABLE TIES

A. Provide hoop and loop cable tries in the communication rooms to loosely bundle and secure cables to the equipment racks and cable tray. Do not use plastic cable tie-wraps.

3.07 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices".

D. Refer to specification 27 05 28 for requirements for labeling of each side of floors and walls with fire rated pathways.

3.08 TRAINING

A. Provide (X) Y hour session(s) of instruction to the Owner on the programming, operation and maintenance of the UPS.

B. Provide (X) Y hour sessions of instruction to the Owner on the programming, operation and maintenance of the power distribution units.

3.09 CLEANING

A. Remove debris, mortar, garbage, wire clippings, dirt and dust from all equipment and room surfaces including, but not limited to, the following.
1. Floors.
2. Walls.
3. Top of equipment racks and cabinets.
4. Top of enclosures.
5. Top of cable trays.
6. Inside of enclosures.
7. Inside of patch panels.

3.10 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION

SECTION 27 13 00 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, labeling and testing of a communication backbone cabling system.

1.02 REFERENCES

A. TIA 455 (Telecommunication industry Association/Electrical Industries Association) Fiber Optic Test Standards.

B. TIA 526 (Telecommunication industry Association/Electrical Industries Association) Optical Fiber Systems Test Procedures.

1.03 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. F/FTP: Overall foil screened cable with foil screened twisted pair.

D. FTP: Shielded twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. S/FTP: Overall braid screened cable with foil screened twisted pair.

M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.04 ACTION SUBMITTALS

A. Product Data:
1. Factory test information for fiber optic cable spools.
2. Materials list.
3. Technical data (cut sheets) for on each component, including finishes and weights.

B. Shop Drawings: Reviewed and stamped by RCDD.
1. Wall and equipment rack elevations for termination, splicing and patching equipment installed under this Work, provided in coordination with the similar Work identified in Sections 27 11 00 and 27 15 00.
2. Sample backbone cable termination schedules for of each type of cable installed under this work. Schedules to include for each cable pair or strand.
a. Building ID.
b. Room ID (location of each end of the cable).
c. Cable ID.
d. Size of Cable.
e. Cable Type.
f. Cable Category.
g. Pair #.
h. Strand #.
i. Rack ID.
j. Wall.
k. Patch panel ID.
l. Termination Block ID.
m. Connector Port #.
n. Connector Type.
o. Row #.
p. Pair #.
q. Associated enlarged communication room drawing.

C. Deferred Submittals:
1. Copies of factory provided cable spool test results.
2. Sample cable test results for each type of cable installed.
3. Sample optical fiber connector face inspection check list.
4. Optical fiber connector cleaning procedures.
5. Statement of field tester apparatus is using the current software or firmware, include software or firmware date.
6. Statement of field tester apparatus last calibration date.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Product Certificates: For each type of product.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual information of the installed work.
   1. Cable termination schedules in Microsoft Excel format (latest version).
   2. Backbone schematics annotated with the approved cable identification numbers.
   3. Cable tests results. Submit cable test results one day after handing off the respective communication rooms to the Owner.
   4. Optical fiber connector face inspection check list.
   5. Factory provided cable spool test results.
   6. Enlarged communication room with equipment rack and wall elevations for cable termination devices.

B. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.07 QUALITY ASSURANCE

A. Testing procedures and field-test instruments shall comply with applicable requirements of:
   1. ANSI Z136.2, ANS For Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources
   2. ANSI/TIA 526, Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant with full OTDR descriptions
   3. ANSI/TIA 526 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
   4. TIA-TSB-4979, Practical Considerations for Implementation of Multimode Launch Conditions in the Field
   5. ANSI/TIA-568, Generic Telecommunications Cabling for Customer Premises
   6. ANSI/TIA-568, Optical Fiber Cabling and Components Standard
   7. ANSI/TIA-606, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements

B. Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
   1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.

2. Manufacturer of the test equipment used for the field certification or representative.
3. Training organization:
   a. BICSI.
   b. Association of Cabling Professionals.
   c. Cabling Business Institute.

C. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

D. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field-testing program development by an RCDD.

E. Installation Supervision: Installation shall be under the direct supervision of Technician or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

F. Testing Supervisor: Currently certified by BICSI as a Technician to supervise on-site testing.

G. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect material from the entrance of dirt, dust, moisture and debris.

B. Maintain attachment of ferrule protector caps on optical fiber couplers and connectors and all pre-terminated cables.

1.09 COORDINATION

A. Coordinate layout and installation of the communication backbone cabling with Owner's telecommunications and network equipment and service suppliers.

B. Coordinate the Work of communications backbone cables in the communication rooms with the 27 11 00 Work to validate that communication equipment rooms are prepared, fitted and ready to receive, terminate, test and protect cables.

C. Coordinate the Work of communication backbone cables with the 27 05 28 Work and the 27 05 30 Work to validate that conduits, sleeves, cable trays, hangars and supports are in place to support and protect cables.

D. Coordinate the final labeling nomenclature for cables, and termination devices with the Owner and Architect prior to installation of cable and device labels. Obtain Owner sign off prior to commencement.

E. Coordinate the format and schema of the cable termination schedules with the Owner and Architect prior to preparation of the schedules. Obtain Owner sign off prior to use on cables and termination devices.

PART 2 - PRODUCTS

2.01 TWISTED PAIR CABLE

A. Performance Requirements
   1. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568, when tested according to test procedures of this standard.
   2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.
   3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
      a. Communications - Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway or Type CMP in listed cable routing assembly.
      b. Communications - Riser Rated: Type CMP or Type CMR in listed plenum or riser communications raceway.
   4. RoHS compliant.

B. Description: 25-pair binder balanced-twisted pair cable, superior to the individual characteristics established in TIA 568 for category 3 cable performance. Complies with ICEA S-90-661 and NEMA WC 63.1.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden
   2. Molex

D. Exterior Rated.
   1. Physical Specifications: 24 AWG, solid copper conductors, 100 Ohm nominal impedance +/ 15 percent.
   2. Cable Construction: Dual insulated with foam skin and plastic, encapsulated with water blocking gel compound, individually insulated conductors, grouped in 25 pair binder units, surrounded by a corrugated aluminum shield, under a common outside plant, duct rated sheath.
   3. NFPA 70 type CMX (rated for use in a wet environment).
   4. Type: ALPESH.
   5. Refer to drawings for pair count.

E. Interior Rated.

1. Physical Specifications: 24 AWG, solid copper conductors, 100 Ohm nominal impedance +/ 15 percent.
2. Electrical Characteristics: Superior to the individual characteristics established in TIA 568 for category 3 cable performance.
3. Cable Construction: individually insulated conductors, grouped in 25-pair binder units under a common sheath. Cable size and noted on the drawings.
4. NFPA 70 type, CMR.
5. Refer to drawings for pair count.

2.02 OPTICAL FIBER CABLES

A. Performance Requirements
1. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568, when tested according to test procedures of this standard.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
3. Flame-Spread Index: 25 or less.
4. Smoke-Developed Index: 450 or less.
5. Standards:
   a. Comply with ICEA S-83-596 for mechanical properties.
   b. Comply with TIA-568 for performance specifications.
   c. Comply with TIA-492AAAC for detailed specifications

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Corning.

C. Single-Mode Optical Fiber Cable (FREEDM® One Tight-Buffered Cable, Riser 6 F, ClearCurve® ZBL, Single-mode (OS2)) :
1. Physical Specifications: 8.3 micron/125 micron, OS2 compliant.
2. Performance Characteristics:

	1310nm	1550nm
a. Maximum Attenuation(dB/km)	.34	.22

3. Cable Construction: Tight buffer, reinforced with a fibrous type strength member, under a common OFNR, OFNP or CMX rated sheath, with no metallic components. Strand count as noted on the drawings.
4. Cable Jacket Color: Yellow,.

2.03 PATCH CORDS

A. LC Duplex Patch Cords:
1. Physical Specifications: 2-strand single-mode optical fiber cable duplex LC connectors with strain relief on both ends.
2. Performance Characteristics: Superior to the individual characteristics established in TIA 568 cable performance.
3. Cable Jacket Color: Aqua.
4. Gender.

2.04 CABLE TERMINATION HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Leviton Manufacturing Co., Inc.

C. Electrical Protection Blocks:
   1. Electrical protection blocks, 110 in - 110 out, complete with solid state connectors, designation strips and grounding/bonding lugs.
   2. Sized to terminate specified cable.
   3. Steel lockable cover.
   4. Mount: Wall.

D. 8-Pin Modular Patch Panel:
   1. 19-inch rack mounted patch panels with 110 connections on the back suitable for the termination of the approved 25-pair binder cables. Complies with TIA-568 category 3, performance. Complete with rear removable cable management/strain relief bars and designation strips.
   2. Universal T568A and T568B wiring labels.
   3. Labeling areas adjacent to conductors.
   4. 24, 48 ports

E. Optical Fiber Patch Panel Enclosure:
   1. 19-inch rack mounted patch panel enclosure with quick release hinged front door, hinged rear door, front facing label panel, designation strips and the following.
      a. Slide out splice trays.
      b. Slide out shelf with, LC, duplex coupler panels and, LC, couplers.
      c. Modular cassette shelves.
      d. Modular cassettes.
      e. Color: White

F. Optical Fiber Pigtail Connectors:
   1. Optical fiber pigtails with LC connectors, suitable for splicing onto the approved optical fiber backbone cables. Insertion loss < 0.2db

2.05 CABLE STORAGE RING

A. Manufacturers:
   1. Leviton.

B. Cable Storage Ring
   1. Surface wall mounted circular ring,
   2. 16-gauge sheet metal.

3. Size: 12-inch diameter with re-closeable/removable 3-inch hook and loop style straps.
4. Size: 24-inch diameter with re-closeable/removable 9-inch hook and loop style straps.

2.06 CABLING IDENTIFICATION

A. Manufacturers:
1. Brady.
2. Panduit.
3. Leviton

B. Comply with TIA-606 and applicable requirements in this section.

C. Machine printed self-adhesive, smudge resistant labels for cables and faceplates. Labels shall be appropriately sized for cable diameter. Labels shall be appropriately colored for face-plate color contrast. Submit sample labels for approval.

2.07 CABLE TAGS

A. Manufacturer:
1. ACP International, Part # CT100

B. Construction: Plastic cable tags with “Caution Fiber Optic Cable” and space for cable information, complete with cable ties.

C. Size: 1.75” x 3.875”

D. Color: Yellow with black lettering (single-mode cable)

2.08 CABLE MECHANICAL PROTECTION

A. Manufacturers:
1. Carlon.
2. Maxcell.
3. Milliken Infrastructure.
4. Prymid.

B. Round Innerduct
1. Construction: Ribbed wall
2. Construction: Multi cell fabric type.
3. Capacity: 3 inch, 3-cell assembly
4. Rating: CMP, CMR or OSP.

C. Fabric Mesh Innerduct:
1. Non-biodegradable outdoor rated fabric mesh, multi-cell, inner duct packs.
2. Each cell provided with a sequential footage marked pull tape.

3. Type 2” wide, 3-cell pack.
4. Rating: OSP.

2.09 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568.

C. Factory test cables according to TIA-568.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing components and adjusting equipment and telecommunication cables. Where no instructions are included with the equipment, follow accepted industry best practices as identified in the BICSI design and installation manual.

B. Keep items protected before and after installation, with dust and waterproof barrier materials. Maintain the integrity of the protective measures throughout the life of the project.

C. Protect communication cables and termination devices from damage during the construction. Do not install communication cables and termination devices in the communications rooms until after the non-Division 27 Work has been completed so that the equipment will not be moved or damaged. Do not install communication cable and termination devices in communications rooms until after plywood backboards have been painted.

D. Maintain safe ingress and egress from work areas during the movement and installation of materials.

E. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work. Where a remedy of unsatisfactory conditions is not available or possible, notify the Architect for resolution.

F. Examine pathway elements intended for the installation and support of communication cables.
   1. Verify the proposed routes of communication cables prior to commencement.
   2. Validate that hangars, conduits, sleeves, conduit/sleeves bushings, cable trays, cable supports, and other elements are in place prior to commencement of any Work. Do not install cable where the cables can be subsequently damaged by other Work.
   3. Validate that the cabling can be installed without subjecting the installed cables to electromechanical interference (EMI). Do not install cable where the cables can be affected by EMI energy.
   4. Validate that the load capacity of cable support structures is adequate to support the cables. Where a cable support is not rated for the required capacity of cables, notify the General Contractor for resolution. Do not proceed until unsatisfactory conditions have been corrected.

G. Clean up and remove all debris generated by installation activities. Keep the communication rooms free of debris.

H. Deliver to Owner two sets of specialty tools specifically needed for proper operation, adjustment and maintenance of cable termination hardware installed under this Contract.

3.02 SURVEY AND PREPARATION

A. Survey and inspect cable trays, conduits, and cable routes prior to commencement of Work and report discrepancies and issues with the use of these for cable installation to the Architect. Failure to perform this inspection and submit the report holds the Contractor at cost risk for corrective actions and schedule impacts later in the Work.

3.03 METHODS AND PROCEDURES

A. Install components in accordance with this Specification, the approved Cable Termination Schedule, the manufacturer’s recommendations and the Drawings.

B. Ensure that communications cable supports (J-hooks, cable tray, conduits, etc.) are fully installed before proceeding with cable installation. Do not allow cables to be installed and left unsupported and or unprotected laying on the floor. Do not tie-wrap cables to any other supporting structure in lieu of specified cable supports. Do not bundle or tie-

wrap the cables even within the approved cable supports. Do not allow the cable to sag more than 12 inches.

C. When anchoring cables to cable supports, use hoop and loop straps only. Do not bundle cables with tie-wraps.

D. When bundling cables, use hook & loop style straps only. Do not bundle cables with tie wraps.

E. Protect cables during installation, especially when cables are laying on the floor, including when inside dedicated communication rooms/spaces. Provide rigid protection for cables left on the floor. Design protection to prevent pressure on cables from walking, equipment placement, or rolled/dragged construction equipment and materials.

F. When installing cables through lateral conduits and sleeves and conduits and sleeves are stacked in more than one row, route cables through the lower row(s) before proceeding to the upper row(s).

G. Support vertical runs of cable with hook and loop straps or split mesh grips on a minimum of 12-foot intervals.

H. When installing cables with metallic strength/protection members, ground the metal member.

I. When installing armored cable, cut the armor with an armor cutting tool designed for cutting armored cables.

J. When installing armored cables, use pulling grips/eyes.

K. When using a pulling grip/eye, use a swivel pull eye.

L. Maintain a minimum bend radius of 20X for interbuilding cables and 15X for interbuilding cables or manufacturer's minimum bend radius of the cables, whichever is greater.

M. Do not stretch, stress, tightly coil, bend or crimp the cables during the installation or when leaving them out of the way of other trades during the staging of the work. Replace abused or stressed cables.

N. When laying cables on a surface during installation, use figure-8 loops to prevent twisting the cables.

O. After dressing the cable to its final location, remove only enough jacketing to allow the conductors to be splayed and terminated in a neat and uniform fashion. Maintain jacketing integrity.

P. When installing twisted pair cable, maintain manufacturers twisting of the cable pairs through to the point of termination.

Q. Install cable in continuous runs without splices or mechanical couplers between the cable points of origin and termination unless identified herein or on the drawings.

R. When pulling cables through conduits, leave in-place drag-lines for future use.

S. Cross communication cables cross over electrical cables and conduits at 90-degree angles. When running twisted pair cables parallel electrical cables or conduits, separate cables by the following minimum distances.
1. Open cables and open power conductors less than 2 kVa: 5 inches.
2. Open cables and open power conductors between 2 kVa and 5 kVa: 12 inches.
3. Open cables and open power conductors greater than 5 kVa: 24 inches.
4. Grounded cable conduits and open power conductors less than 2 kVa: 3 inches.
5. Grounded cable conduits and open power conductors between 2 kVa and 5 kVa: 6 inches.
6. Grounded cable conduits and open power conductors greater than 5 kVa: 12 inches.
7. Grounded cable conduits and grounded power conduits less than 2 kVa: 0 inches.
8. Grounded cable conduits and grounded power conduits less than 5 kVa: 3 inches.
9. Grounded cable conduits and grounded power conduits greater than 5 kVa: 6 inches.
10. Cables and electrical motors and transformers: 48 inches.
11. Cables and fluorescent light fixtures: 5 inches.

3.04 INNERDUCT

A. Provide plastic tube Innerducts in the inter-building conduits. Stub the innerducts into the utility vaults and communications rooms and secure to structure. Provide, four 1 inch.

B. Provide plastic tube. Stub the innerducts into the communications rooms and secure to structure.

3.05 CABLING

A. Refer to the Drawings for cable sizes and quantities.

B. Coordinate Work in the existing communications rooms with the Owner prior to the commencement of Work.

C. Do not cause any harm to the existing operations in the communications room.

D. Do not cause harm to existing cables along the cable route.

E. Provide 10-foot service loops in utility vaults and hand holes.

F. Provide 10-foot service loops in communication rooms. Provide cable storage rings to manage the service loops. Locate service loops on the wall 24 inches above the cable tray.

G. Provide 10-foot service loops in pull boxes installed at structural expansion joints.

H. Route the cables through the inter-building and intra-building backbone pathway system as shown on the Drawings.

I. Provide inter-building twisted pair backbone cables as shown on the Drawings. Terminate the cables onto electrical protection blocks on both ends.

J. Provide twisted pair tie cables from electrical protection blocks to the corresponding termination blocks in the communication rooms to match all inter-building backbone cables installed under this work.

K. Provide twisted pair backbone cables as shown on the Drawings. Terminate the cable onto, 8-pin modular patch panels (1-pair per port, terminated on pins 4 & 5) in the communication rooms and onto, 8-pin modular patch panels in the main communication rooms.

L. Provide inter-building single-mode optical fiber cables as shown on the Drawings. Splice the cables onto LC, pigtailed connectors. Mount the connectors in optical fiber patch panels on both ends. Refer to Drawings for conduit routes.

M. Support vertical runs of cable with hook and loop straps or split mesh grips.

N. Ground metallic strength members of cables.

3.06 TERMINATION DEVICES

A. Coordinate location of termination devices in the communication room with the coordinated 27 11 00 Shop Drawings prior to commencement of Work.

B. Coordinate the location of new termination devices installed in the existing equipment racks with the Owner prior to commencement of Work.

C. Provide electrical protection blocks in the communication rooms for the termination of inter-building twisted pair cables installed under this Work. Mount the protection blocks onto the plywood backboards. Provide protection blocks complete with cable identification strips and solid-state protectors. Turn over unused protectors to the Owner at the project completion. Ground all electrical protection blocks per manufacturer's recommendations.

D. Provide termination blocks in the communication rooms for the termination of twisted pair cables installed under this Work. Mount the termination blocks onto the plywood backboards in the communication rooms. Provide termination blocks complete with cable identification strips and legs.

E. Provide patch panels in communication rooms for the termination of all twisted pair cables installed under this work. Mount the patch panels onto the equipment racks. Provide patch panels complete with connectors and cable identification strips.

F. Provide optical fiber patch panels in the communications rooms for the termination of optical fiber cables installed under this Work. Mount the patch panels onto the equipment racks in the communication rooms. Provide patch panels complete.

3.07 PIGTAIL/CONNECTORS

A. Provide LC pigtailed connectors for splicing of single-mode optical fiber cables installed under this Work.

3.08 PATCH CORDS

A. Provide optical fiber patch cords for Owners use.
1. Single-mode LC to LC duplex patch cords, Length - 12 feet. Quantity – 24.

B. Visually inspect patch cords as described in 3.10 Field Quality Control prior to Owner's installation of patch cords. Coordinate the scheduling of patch cord installation with Owner so that the visual inspection and the installation occur at the same time.

C. Install patch cords as directed by the Owner. Visually inspect patch cords as described in 3.10 Field Quality Control.]

3.09 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.10 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607 and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect

grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.11 IDENTIFICATION

A. Provide identification labels that are in accordance with the approved cable termination schedule.

B. Room numbers shown on the Drawings may not the final room numbers. Validate the final room numbers with the Architect prior to use in creating termination schedules, cable identification labels, cable record drawings, O&M documentation, and cable test reports.

C. Provide machine-generated labels on cables in black uppercase lettering on a permanent adhesive, white label stock, covered with a permanent water-resistant sealer. Place labels on both ends of each cable and no more than 6 inches from the point at which the cable is broken out into individual copper pairs or strands from the connector or termination block or patch panel. Install labels so that the labels are parallel with the cable. Install labels so that labels are readily visible. Do not label cables with hand lettered labels.

D. Provide machine-generated labels on termination block with the cable ID and cable pair in uppercase lettering. Do not label devices with hand lettered labels.

E. Provide machine-generated labels on splice panel with the equipment rack or equipment cabinet ID and the rack unit position in uppercase lettering. Do not label devices with hand lettered labels.

F. Provide machine-generated labels on patch panel, with the cable ID and port number in uppercase lettering. Do not label devices with hand lettered labels.

G. Replace labels if at any time during the project, the label becomes illegible or is removed.

H. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

3.12 FIELD QUALITY CONTROL

A. Provide an updated cable test plan submitted and approved as part of the Submittals process. Refer to article 1.03.E.3.

B. Notify the Architect, Owner and Engineer a minimum of 5 days in advance of the commencement of cable testing so that they can meet the cable tester at the site to observe the tester setup and the initial testing of cables.

C. Follow safety precautions in accordance with ANSI Z136.2 when performing test on optical fiber cabling that use a test set with a VCSEL, laser or LED.

D. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords and labeling of components.

E. Use testers that have been factory recalibrated within the last 12 months.

F. Use test instruments that meet or exceed applicable requirements in TIA 568.

G. Use testers with current test firmware installed within.

H. Comply with TIA 1152 Field Test Standard.

I. Set cable testers to reject Pass* (star) results.

J. Use connector insertion loss limits as identified by the connector manufacturer (as opposed to the TIA worst case limit) when comparing actual optical fiber cable test results with the expected optical cable test results.

K. Use pigtail connector insertion loss limits as identified by the pigtail connector manufacturer (as opposed to the TIA worst case limit) when comparing actual optical fiber cable test results with the expected optical cable test results.

L. Use splice insertion loss limits as identified by the splice manufacturer (as opposed to the TIA worst case limit) when comparing actual optical fiber cable test results with the expected optical cable test results.

M. Twisted Pair Cable Test:
   1. Test all cable, all pairs.
   2. Test category 3 twisted pair cables for wire map and continuity.

N. Tier 1 Optical Fiber Cable/Connector Test and Certification:
   1. Test all cables, all strands.
   2. Acceptable test value calculation:
      a. Coordinate and establish an approved optical fiber cable loss budget with the Engineer prior commencement of cable testing.
      b. Use connector insertion loss limits as identified by the connector manufacturer (as opposed to the TIA worst case limit) when comparing actual optical fiber cable test results with the expected optical cable test results.
      c. Use pigtail connector insertion loss limits as identified by the pigtail connector manufacturer (as opposed to the TIA worst case limit) when

comparing actual optical fiber cable test results with the expected optical cable test results.

d. Use splice insertion loss limits as identified by the splice manufacturer (as opposed to the TIA worst case limit) when comparing actual optical fiber cable test results with the expected optical cable test results.

3. When using a connector end-face cleaning solvent, use a non-IPA solvent.
4. When using a connector end face wipe or swab, use lint-free non-static wipes or swabs.
5. Use a light source and power meter (LS/PM) tester that meet or exceed applicable requirements in TIA 526-14-C-2015, TIA 527-7A and TIA-568 requirements to test optical return loss, length and polarity (fiber mapping).
6. Use referenced-grade launch cords and adapters approved by the test equipment manufacturer for channel or link tests.
7. Allow tester light sources to warm up and stabilize before commencing tests.
8. Utilize reference grade jumper reference cords.
9. Test reference test cords and replace if the reference test cords are out of tolerance.
10. Multi-mode cable: Conduct an end -to-end attenuation test at 850 nm and 1300 nm in accordance with TIA-526-14-A, Method A, and one reference jumper. Attenuation test results shall be less than that calculated according to equation in TIA-568.
11. Single-mode cable: Conduct an end -to-end attenuation tests at 1310 nm and 1550 nm in accordance with TIA-526-7 Method A, and one reference jumper. Attenuation test results shall be less than that calculated according to equation in TIA-568B.
12. After a fiber strand test is complete, immediately replace dust cap onto the connectors/ couplers.
13. Save test results in tester native file format.
14. Include the tester loss limit in the tester result fields.
15. Include the tester calibration date in the tester result fields.
16. Include the tester firmware date in the tester result fields.
17. Include the tester application limits in the tester result fields.
18. After testing is complete, and just prior to hand off to the Owner,
    a. Remove connector and couplers ferrule protector caps and store in a dust free container and immediately commence cable tests.
    b. Clean the end faces of the connectors.
    c. Visually inspect connectors, cassettes and bulkheads using a powered inspection-microscope in accordance with IEC 61300-3-35.
    d. After testing is complete, and just prior to hand off to the Owner, visually inspect the end faces of connectors, cassettes and bulkheads at each end of the cables using a powered visual inspection probe with a field of view

425 µm x 320 µm. Record end face images and upload to a PC for review. The following test limits shall be used
1) Multi-mode connectors; Table 6 of IEC 61300-3-35 Edition 1.0
2) Single-mode field polished connectors; Table 5 of IEC 61300-3-35 Edition 1.0
3) Single-mode factory polished connectors; Table 3 of IEC 61300-3-35 Edition 1.0
4) Angled Physical Contact (APC) connectors; Table 4 of IEC 61300-3-35 Edition 1.0

e. Clean connectors if dirt/particles were observed.
f. Replace connectors if scratches or defects larger or at a quantity higher than allow in IEC 61300-3-35 were observed.
g. Re-inspect connector end faces

O. Tier 2 Optical Fiber Cable Test and Certification (installed):
1. Remove connector and couplers ferrule protector caps and store in a dust free container and immediately commence cable tests.
2. Use an optical time domain reflectometer (OTDR) tester that meet or exceed applicable requirements in TIA 526-14-C-2015, TIA 527-7A and TIA-568 requirements.
3. Use referenced-grade launch cords and adapters approved by the test equipment manufacturer for channel or link tests, minimum length of 10 meters.
4. Allow tester light sources to warm up and stabilize before commencing tests.
5. Utilize reference grade jumper launch cords.
6. Test reference test cords and replace if id the reference test cords are out of tolerance.
7. Multi-mode cable: Conduct an end -to-end attenuation test at 850 nm and 1300 nm in accordance with TIA-526-14-A, Method A, and one reference jumper. Attenuation test results shall be less than that calculated according to equation in TIA-568.
8. Single-mode cable: Conduct an end -to-end attenuation tests at 1310nm and 1550 nm in accordance with TIA-526-7, Method A and one reference jumper. Attenuation test results shall be less than that calculated according to equation in TIA-568.
9. Test cable strands cables longer than 300 meters or cables with splices using an OTDR.
10. Print visual map (screen shot) of scope screen.
11. After test is complete, immediately replace ferrule protector caps onto connectors and couplers.
12. Include the tester reflectance limit in the tester result fields.
13. Include the tester calibration date in the tester result fields.
14. Include the tester firmware date in the tester result fields.
15. After testing is complete, and just prior to hand off to the Owner,
    a. Remove connector and couplers ferrule protector caps and store in a dust free container and immediately commence cable tests.
    b. Clean the end faces of the connectors.

c. Visually inspect connectors, cassettes and bulkheads using a powered inspection-microscope in accordance with IEC 61300-3-35.
d. After testing is complete, and just prior to hand off to the Owner, visually inspect the end faces of connectors, cassettes and bulkheads at each end of the cables using a powered visual inspection probe with a field of view 425 µm x 320 µm. Record end face images and upload to a PC for review. The following test limits shall be used
    1) Multi-mode connectors; Table 6 of IEC 61300-3-35 Edition 1.0
    2) Single-mode field polished connectors; Table 5 of IEC 61300-3-35 Edition 1.0
    3) Single-mode factory polished connectors; Table 3 of IEC 61300-3-35 Edition 1.0
    4) Angled Physical Contact (APC) connectors; Table 4 of IEC 61300-3-35 Edition 1.0
e. Clean connectors if dirt/particles were observed.
f. Replace connectors if scratches or defects larger or at a quantity higher than allow in IEC 61300-3-35 were observed.
    1) Re-inspect connector end faces.
g. Replace ferrule protector caps on optical fiber couplers and connectors.

P. If at any time optical fiber ferrule protector caps are removed from the couplers or connectors, re-test the cable before re-installing the ferule protector caps.

Q. Repair or remove/replace cabling where test results do not comply with specified requirements. Retest repaired cables

R. Test Reports:
1. Document test data for each cable test measurement.
2. Provide a summary report that is formatted consistent with Table 10.1 in BICSI TDM.
3. Provide a link to tester manufacturer’s website to access cable test results.
4. Provide a USB Flash Drive containing the cable test reports in the PDF format.
5. Provide a USB Flash Drive containing individual cable reports in the native file structure of the test instrument(s). Provide software to display and print individual and summary cable test reports from the native test files.

S. After the installation is complete, in addition to any other required testing as described herein, and at such times as the Owner/Engineer directs, the Contractor shall be present while the Owner conducts an operating test of network components for approval. The installation shall be demonstrated to be in accordance with the requirements of this

specification. Any defects revealed shall be corrected promptly at the Contractor's expense and the tests performed again.

T. Testing Agency: Engage a qualified testing agency to perform tests and inspections.]

END OF SECTION

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes furnishing materials, equipment, labor, supervision, tools and items necessary for the construction, installation, labeling and testing of a communication horizontal cabling system.

B. The horizontal cable system shall be a complete certified system as offered by a single manufacturer. The system cables and components shall be performance matched, approved for use with a single manufacturer and guaranteed by the manufacturer.

1.02 REFERENCES

A. Section 27 11 00 Communication Equipment Room Fittings.

1.03 SUMMARY

A. Section Includes:
1. Category 6 and 6a twisted pair cable.
2. Twisted pair cable hardware, including 8-pin patch panels, modular plugs and connectors.
3. Cable management system.
4. Cabling identification products.
5. Grounding provisions for twisted pair cable.
6. Source quality control requirements for twisted pair cable.

1.04 DEFINITIONS

A. Bundle: A group of cables that are lashed/tied together or in contact with one another in a closely packed configuration for at least 36 inches

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. FTP: Shielded twisted pair.

E. F/FTP: Overall foil screened cable with foil screened twisted pair.

F. F/UTP: Overall foil screened cable with unscreened twisted pair.

G. IDC: Insulation displacement connector.

H. LAN: Local area network.

I. Connector: Also commonly called a "Jack", female communications cable connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. Terminated Link: Also commonly called a "plug", male communication cable connector.

P. UTP: Unscreened (unshielded) twisted pair.

1.05 ACTION SUBMITTALS

A. Manufacturer’s Instructions:
1. Submit application conditions and limitations of use stipulated by the manufacturer.
2. Submit manufacturer’s instructions for storage, handling, protection, examination, preparation, operation and installation of product.
3. A letter from the cable termination hardware component Manufacturer, stating that the product set offered, with the identified system installers meet the Manufacturer’s requirements to provide a Performance Warranty to the Owner at the completion of the project.

B. Product Data:
1. Materials list.
2. Technical data (cut sheets) for on each component.

C. Shop Drawings:
1. Wall and equipment rack elevations for termination and patching equipment installed, provided in coordination with the similar work identified in Sections 27 11 00 and 27 13 00.
2. Floor plans showing the communication outlets and their associated cable identification number.
3. Sample horizontal cable termination schedules for of each type of cable installed. Schedules to include for each cable pair or strand.
4. Sample horizontal cable termination schedules for of each type of cable installed under this work.
   a. Building ID.

b. Room ID.
c. Cable Category.
d. Cable ID.
e. Outlet ID.
f. Outlet Port #.
g. Communication Room ID.
h. Rack.ID
i. Patch Panel ID.
j. Patch Panel Port #
k. Termination Block ID.
l. Pair.
m. Row.

5. Sample cable test results for each type of cable installed.
6. Sample cable labels.
7. Associated enlarged communication room drawing.
8. Associated floor plan drawing.

D. Deferred Submittal
1. Statement of field tester apparatus is using the current software or firmware, include software or firmware date.
2. Statement of field tester apparatus last calibration date.
3. Cable performance test plan, procedure, and schedule. Identifying tester manufacturer and model, and date of the last tester calibration. Note that cable tests with Pass * (star) results will not be accepted.

E. Qualifications:
1. Submit resumes and certifications of technicians and project managers who will support the installation.

F. Field Quality-Control Submittals:
1. Field quality-control reports.

1.06 INFORMATIONAL SUBMITTALS

A. Manufacturer’s Certification and Qualification Data: For RCDD, installers, installation supervisor, and system tester.

B. Source quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Provide in accordance with Section 27 05 00 - Common Work Results for Communication Systems.

B. Project Record Documents:
1. Record actual information of the installed Work.

2. Floor plans showing the communication outlets and devices and their associated cable identification number. Identify locations where cables pass through fire-rated walls.
3. Cable termination schedules in Microsoft Excel format (latest version).
4. Cable tests results. Submit cable test results prior to handing off the respective communication rooms to the Owner.
5. Enlarged communication room with equipment rack and wall elevations for cable termination devices.

C. Certificate of acceptance testing.

D. Cable Performance Warrantees.

1.08 QUALITY ASSURANCE

A. All testing procedures and field-test instruments shall comply with applicable requirements of:
1. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
2. ANSI/TIA-568, Generic Telecommunications Cabling for Customer Premises.
3. ANSI/TIA-568, Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA 568, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
5. ANSI/TIA 568, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
6. ANSI/TIA-606, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.

B. Use trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof to execute cable tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
1. Manufacturer of the connectors or cable.
2. Manufacturer of the test equipment used for the field certification.
3. Training organizations
   a. BICSI.
   b. Association of Cabling Professionals.
   c. Cabling Business Institute.

C. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Technician or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

D. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect material from the entrance of dirt, dust, moisture and debris

1.11 COORDINATION

A. Coordinate the Work of communication horizontal cables in the communication rooms with the 27 11 00 Work to validate that communication equipment rooms are prepared, fitted and ready to receive, terminate and protect cables.

B. Coordinate the Work of communication horizontal cables with the installation of elevator cabs to support communication devices, cameras and video displays.

C. Coordinate the Work of communication horizontal cables in the ceiling and workstation areas with the 27 05 28 Work and the 27 05 36 Work to validate that conduits, sleeves, cable trays, hangars and supports are in place to supported and protect cables.

D. Coordinate the Work of communication horizontal cables to video surveillance cameras with the 28 13 01 to validate how cameras may be mounted at the end of wall, ceiling, pole and parapet mounting brackets and arms.]

E. Coordinate the final labeling nomenclature for cables, and termination devices with the Owner and Architect prior to installation of cable and device labels. Obtain Owner sign off.

F. Coordinate the format and schema of the cable termination schedules with the Owner and Architect prior to preparation of the schedules. Obtain Owner sign off prior to use on cables and termination devices.

G. Coordinate layout and installation of communications and network equipment and cabling with Owner's communications and network equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568, when tested according to test procedures of this standard.

B. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70.

C. RoHS compliant.

2.02 UNSHIELDED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden
2. Berk-Tek.
3. CommScope
4. General Cable; Prysmian Group North America.
5. Mohawk.
6. Superior Essex Inc.
7. Systimax.
8. Or approved Equivalent

C. Unshielded Twisted Pair:
1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.
3. Cable construction: round cable, individually insulated conductors under a common sheath.
4. NFPA 70 type CMP,.
5. Cable Jacket Color: Blue.

D. Unshielded Twisted Pair:
1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.
3. Cable construction: round cable, individually insulated conductors under a common sheath.
4. NFPA 70 type CMX, CMR-CMX, CMP-CMX (rated for installation in a

E. Cable Unshielded Twisted Pair Limited Power:

1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 5e cable performance.
3. Cable construction: round cable, individually insulated conductors under a common sheath.
4. Compliant with IEE802.3bt 4PPOE requirements in support of 100 watts power delivery to devices.
5. UL limited power (LP) certified for temperature rating.
6. NFPA 70 type CL2P CL3P, CL2R, CL3R.
7. Cable Jacket Color: Blue.

F. Unshielded Twisted Pair:
1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.
3. Cable construction: round cable, individually insulated conductors under a common sheath.
4. UL limited power (LP) certified for temperature rating.
5. NFPA 70 type CL2P CL3P, CL2R, CL3R.
6. Cable Jacket Color: Blue.

2.03 SHIELDED TWISTED-PAIR CABLES

A. Description: Four-pair, balanced-twisted pair cable.

B. Approved Manufacturers:
1. Berk-Tek.
2. Belden.
3. General Cable.
4. Mohawk.
5. Systimax.

C. Shielded Twisted Pair:
1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.
3. Cable construction: round cable, foil shield, individually insulated conductors under a common sheath.
4. NFPA 70 type CMP, CMR.
5. Cable Jacket Color: Blue.

D. Shielded Twisted Pair:
   1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
   2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.
   3. Cable construction: round cable, overall shield, with individually shielded insulated conductors under a common sheath.
   4. NFPA 70 type CMP, CMR.
   5. Cable Jacket Color: Blue.

E. Shielded Twisted Pair:
   1. Physical specifications: 4 twisted pair, 23 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
   2. Electrical characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance. 600AWM rated.
   3. Operating temperature range: -40 degree F to 167 degrees F.
   4. Cable construction: round cable, overall shield, with individually shielded insulated conductors under a common sheath with drain wire.
   5. NFPA 70 type CMX/CMR.
   6. Cable Jacket Color: Black

F. Shielded Twisted Pair:
   1. Physical specifications: 4 twisted pair, 22 AWG, solid copper conductors, 100 Ohm nominal impedance and impedance tolerance plus or minus 15 percent. Comply with UL 444.
   2. UL limited power (LP) certified for temperature rating.
   3. Cable construction: round cable, XTP or non-continuous (intermitted) - variable length segment foil/shield, individually insulated conductors under a common sheath.
   4. NFPA 70 type CMP, CMR.
   5. Cable Jacket Color: Blue.

2.04 PATCH CORDS AND EQUIPMENT CORDS

A. Manufacturers – Match the manufacturer of the approved cable or the approved patch panel.

B. 8-Pin Modular-to-8-pin Modular UTP, Patch/Equipment Cords:
   1. Physical Specifications: 4-pair cable, with male 8-pin modular plugs with insert molded strain relief on both ends.
   2. Performance Characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.
   3. 24 AWG.
   4. Cable Jacket Color: Blue.

C. Antibacterial 8-Pin Modular-to-8-pin Modular UTP Patch/Equipment Cords:
1. Physical Specifications: 4-pair cable, with permanent antibacterial jacketing and antibacterial male 8-pin modular plugs with insert molded strain relief on both ends.
2. Performance Characteristics: Superior to the individual characteristics established in TIA 568 for category 6 cable performance.

2.05 CABLE TERMINATION HARDWARE

A. Description: Hardware designed to connect, splice, and terminate horizontal communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Leviton

C. 8-Pin Modular Patch Panel (Flat QUICKPORT™ Patch Panel, 24-Port, 1RU, Black.) :
1. 48, 24-port, 19-inch rack mounted, with 110 connections on the back suitable to terminate on the approved 4-pair cables. Comply with TIA-568-B category 6. performance. Wired with T568 B pinning. Complete with rear removable cable management/strain relief bars, and designation strips.

D. 8-Pin Modular Connectors:
1. 100-ohm, balanced, 8-pin modular connectors suitable to terminate on the approved 4-pair cables. Comply with TIA- 568 category 6. performance. Outlet wired with standards compliant T568- B pinning.
a. Standard Data = White
b. Wireless = Green
c. Security = Black

E. Faceplate:
1. High-impact plastic or stainless steel. Single gang with one, two or four ports for 8-pin modular connectors. Coordinate color and material with Architect.
2. High-impact plastic. Single gang with one, two or four ports for 8-pin modular connectors housed at 45 degrees to the wall. Coordinate color and material with Architect.
3. High-impact plastic or stainless steel. Double gang with four, six or more ports for 8-pin modular connectors. Coordinate color and material with Architect.
4. High-impact plastic or stainless steel. Single gang with ports for one 8-pin modular, one F connector and one nurse call system connector.
5. Stainless steel faceplate, single gang with two mounting studs to support wall mounted telephone with one 8-pin modular connector.
6. High-impact plastic mounting (106 frame) plate, suitable to mount one, two or four approved 8-pin modular connectors and mount behind a NEMA type mounting plate in a floor box, poke through device or surface mounted raceway.
7. Snap on dust covers for unused faceplate ports.

2.06 DIN RAIL

A. DIN rail mounting track, 1.38-inches (35-mm) wide, 6-inches deep, 36 inches long, complete with mounting, flat brackets, flange adapter and isolators.

B. Material: Steel.

2.07 WIRE DUCT.

A. Large finger wire duct, 3/4-inches wide, 2-inches deep with snap on cover.

2.08 CABLE MANAGEMENT HARDWARE

A. Approved Manufactures:
1. Chatsworth.
2. CommScope.
3. Leviton.
4. Ortonics.
5. Panduit.
6. Siemon Company.
7. Systimax.

B. Horizontal Cable Management:
1. 19-inch rack mount,, single, double-sided full width. 1, 2, RU height.
2. Split 6-inch-deep D-ring cable guides.
3. Tee shaped cable guides, with snap on front cover, reversible hinged front cover.
4. Color to match the equipment rack or cabinet Rack Mounted Wire Management.

C. Horizontal Lacer Bar
1. 19-inch rack mount.
2. 3/8 -inch round.
3. Depth: Minimum 4-inches.
4. Material: Steel.

2.09 CABLE MANAGEMENT STRAPS

A. Reusable hook and loop type (Velcro style) reusable straps, 3/4 inch wide.

2.10 IDENTIFI IDENTIFICATION LABELS

A. Approved Manufactures:
1. Panduit.
2. Brady.

B. Comply with TIA-606 and applicable requirements in this section.

C. Machine printed self-adhesive, smudge resistant labels for cables, patch panels and faceplates. Labels shall be appropriately sized for relative cable diameters. Labels shall be appropriately colored for face-plate color contrast. Submit sample labels for approval.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568.

C. Factory test twisted pair cables according to TIA-568.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing components and adjusting equipment and telecommunications cables. Where no instructions are included with the equipment, follow accepted industry best practices as identified in the BICSI design and installation manual.

B. Provide equipment and component mounting hardware.

C. Keep items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures throughout the life of the project.

D. Comply with 27 05 30 Hangars and Supports for Communication System Cables" for requirements for the installation of cables supports:
   1. Size.
   2. Spacing.
   3. Access.
   4. Cable bundles.

E. Protect communications cable and termination devices from damage during the construction. Do not install communication cables and termination devices in the communications rooms until the other trades have completed their work in the areas so that the equipment will not be moved or damaged. Do not install communication cable and termination devices in communications rooms until after plywood backboards have been painted.

F. Maintain safe ingress and egress from work areas during the movement and installation of materials.

G. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely

completion of the Work. Where a remedy of unsatisfactory conditions is not available or possible, notify the Architect for resolution. Do not proceed until unsatisfactory conditions have been corrected.

H. Examine pathway elements intended for the installation and support of communication cables.
   1. Verify the proposed routes of communication cables prior to commencement.
   2. Validate that hangars, conduits, sleeves, conduit/sleeves bushings, cable trays, cable supports, and other elements are in place prior to commencement of any Work. Do not install cable where the cables can be subsequently damaged by the Work of other Trades.
   3. Validate that the cabling can be installed without subject the cables to electromechanical interference (EMI). Do not install cable where the cables can be affected by EMI energy.
   4. Validate that the load capacity of cable support structures is adequate to support the cables. Where a cable support is not rated for the required capacity of cables, notify the Architect for resolution. Do not proceed until unsatisfactory conditions have been corrected.

I. Deliver to Owner two sets of special tools specifically needed for proper operation, adjustment and maintenance of cable and cable termination hardware installed under this Contract.

3.02 SURVEY AND PREPARATION

A. Survey and inspect cable trays, conduit paths and routes prior to commencement of Work and report discrepancies and issues with the use of these for cable installation. Failure to perform this inspection and submit the report holds the Contractor at cost risk for corrective actions and schedule impacts later in the Work.

3.03 METHODS AND PROCEDURES

A. Install components in accordance with this Specification, the approved Cable Termination Schedule, the manufacturer's recommendations, and the Telecommunications Distribution Drawings.

B. Ensure that telecommunications cable supports (J-hooks, cable tray, conduits, etc.) are fully installed before proceeding with cable installation. Do not allow cables to be installed and left unsupported. Do not allow cables to be supported to other supporting structure in lieu of specified cable supports.

C. When anchoring cables to cable supports, use hoop & loop straps only. Do not use tie wraps.

D. When bundling cables, use hook & loop style straps only. Do not bundle cables with tie wraps or cable mesh/socks.

E. Do not group more than 24 cables in a single bundle. Create multiple bundles when the size of a bundle exceeds 24 cables.

F. Continuously protect cables during installation, especially when the cables are coiled on floor(s), including dedicated communication spaces. Provide rigid protection for cables left on floor at any time during construction. Design protection to prevent pressure on cables from walking, equipment placement, or rolled/dragged construction equipment and materials.

G. When installing cables through lateral conduits and sleeves and conduits and sleeves are stacked in more than one row, route cables through the lower row(s) before proceeding to the upper row(s).

H. When installing cables through vertical conduits and sleeves and conduits and sleeves are stacked in more than one row, route cables through the back row(s) before proceeding to the forward row(s).

I. Provide J-Hooks where no other cable supports are available. Refer to 27 05 30 “Hangars and Supports for Communication System Cables” for additional information.
   1. Install J-Hooks so that cables are supported at maximum intervals of 48 inches.
   2. Install J-Hooks so that the sag in the cables between the J-Hooks is less than 12 inches.
   3. Install J-Hooks at a height above the finished ceiling so that the sag in the cables between J-hooks is greater than 5 inches above the top of the ceiling tile or light fixtures.

J. Maintain manufacturer's recommended minimum bend radius of the cables. Do not stretch, stress, tightly coil, bend or crimp the workstation cables during the installation or when leaving them out of the way of other trades during the staging of the work. The Contractor, at the Contractors expense shall replace abused or stressed cables.

K. After dressing the cable to its final location, remove only enough jacketing to allow the conductors to be splayed and terminated in a neat and uniform fashion. Maintain jacketing integrity by removing only as much jacketing as is practical, to accomplish termination. For twisted pair cables, maintain the manufacturers twisting of the wire pairs through to the point of termination.

L. Install cable in continuous runs without splices or mechanical couplers between the cable points of origin and termination for the inter-building and intra-building cable.

M. Terminate cables neatly, with enough slack (3 inches to 9 inches) to pull off, test and re-terminate each cable as needed.

N. Provide an 18-inch service loop in the ceiling above the communication outlet.

O. Provide a 24 inch service loop in the cable bundles in the cable tray above the equipment racks stored in a figure-8 configuration.

P. When pulling cables through conduits, leave in-place drag-lines for future use.

Q. Cross communication cables cross over electrical cables/conduits at 90-degree angles.

R. When running twisted pair cables parallel electrical cables/conduits, separated cables by a minimum of the following.
1. Open cable and open power conductors less than 2 kVa: 5 inches.
2. Open cable and open power conductors less than 5 kVa: 12 inches.
3. Open cable and open power conductors greater than 5 kVa: 24 inches.
4. Grounded cable conduits and open power conductors less than 2 kVa: 3 inches.
5. Grounded cable conduits and open power conductors less than 5 kVa: 6 inches.
6. Grounded cable conduits and open power conductors greater than 5 kVa: 12 inches.
7. Grounded cable conduits and grounded power conduits less than 2 kVa: 0 inches.
8. Grounded cable conduits and grounded power conduits less than 5 kVa: 3 inches.
9. Grounded cable conduits and grounded power conduits greater than 5 kVa: 6 inches.
10. Cables and electrical motors and transformers: 48 inches.
11. Cables and fluorescent light fixtures: 5 inches.

3.04 CABLING

A. Schedule a meeting with the Architect and Owner to identify and discuss and confirm how cables will be routed, dressed and bundled into the cable tray and equipment racks, vertical cable managers and horizontal cable managers installed with the communication rooms prior to commencement of cable termination.

B. Provide 4-pair UTP cables from the respective communication rooms to the wall mounted communication outlets as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors at the outlet location. Route the cable in the accessible ceiling areas. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

C. Provide 4-pair UTP cables from the respective communication rooms to the communication outlets for wireless access point devices as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular plugs at the device location. Route the cable in the accessible ceiling areas. Provide 15-feet of slack in the ceiling. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

D. Provide 4-pair UTP cables from the respective communication rooms to the communication outlets for room scheduler devices as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin

modular plugs at the device location. Route the cable in the accessible ceiling areas. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

E. Provide 4-pair UTP cables from the respective communication rooms to the communication outlets for video surveillance cameras as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular plugs at the device location. Route the cable in the accessible ceiling areas. Provide 15-feet of slack in the ceiling. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

F. Provide 4-pair UTP cables from the respective communication rooms to the communication outlets for video projectors as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors at the outlet. Route the cable in the accessible ceiling areas. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

G. Provide 4-pair UTP cables from the respective communication rooms to the communication outlets for room schedulers as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors at the outlet. Route the cable in the accessible ceiling areas. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

H. Provide 4-pair UTP cables and coaxial cables from the respective communication rooms to the wall mounted communication outlets as shown on the drawings. Terminate the UTP cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors at the outlet location. Terminate the coaxial cable with an F connector on each end. Coil coaxial cables in the communication room at one location. Route the cable in the accessible ceiling areas. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

I. Provide 4-pair UTP cables from the respective communication rooms to the communication outlets in the floor box/poke through devices as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors with a mounting plate at the outlet location. Route the cable in conduits through the slab and up a wall to an accessible ceiling area. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

J. Provide outdoor rated 4-pair UTP cables from the respective communication rooms to the communication outlet at floor boxes located in areas with slab-on-grade. Where the cable run is exposed for more than 50 feet inside the building, interconnect the cable to an indoor rated cable so that the maximum length of outdoor rated cable is less than 50 feet. Provide a metallic enclosure in the ceiling area to house the interconnection device. Terminate the cables onto 8-pin modular patch panels in the communication rooms and

onto 8-pin modular plugs or connectors at the outlet location. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

K. Provide 4-pair cables from cables from the respective communication rooms to the communication outlets in case work, millwork and modular furniture as shown on the drawings. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors at the outlet location. Route the cables down the conduit stub-up or up from a conduit sleeve into the in-feed of the raceway internal to the casework, millwork or modular furniture. Route the cables into and within the raceway of the casework, millwork or modular furniture to the outlet location. Coordinate Work with the installation of the casework and millwork and the furniture system vendor prior to commence of work. Terminate and test the cables after the final casework, millwork and modular furniture assembly is complete.

L. Provide outdoor rated 4-pair UTP cables from the respective communication rooms to the communication outlet at the locations exterior to the building as shown on the drawings. Where the cable run is exposed for more than 50 feet inside the building, interconnect the cable to an indoor rated cable so that the maximum length of outdoor rated cable is less than 50 feet. Provide a metallic enclosure in the ceiling area to house the interconnection device. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular plugs or connectors at the outlet location. Support the cables with J-hooks installed at a maximum separation of 48 inches in route back to the cable trays.

M. Provide 4-pair cables from cables from the respective communication rooms to communication outlets or devices in
1. Elevator control panels/enclosures, three cable for each elevator cab.
2. Building management system panels/enclosures.
3. Energy management system panels/enclosures.
4. Lighting control panels/enclosures.
5. Fire alarm control system panels/enclosures.
6. Access control system panels/enclosures.
7. Photovoltaic inverters/enclosures.
8. Irrigation controllers/enclosures.
9. EV automobile charging stations.

N. Terminate the cables onto 8-pin modular patch panels in the communication rooms and onto 8-pin modular connectors at the outlet or device location. Route the cables across the ceiling of the rooms and into the in-feed of the equipment room. Route the cables into and within the raceway of the booms to the outlet location. Coordinate work with boom vendor. Terminate and test the cables after the final boom assembly is complete.

3.05 CONNECTORS/FACEPLATES

A. Provide 8-pin modular connectors for the termination of 4-pair cables.]

B. Provide an accompanying faceplate, mounting plate or surface mount box at the appropriate outlet location. Install faceplates level and align to adjacent outlet faceplates. Provide dust caps on an unused port. Coordinate color and material with Architect.

C. Provide an accompanying faceplate suitable to mount an 8-pin modular connector and an F connector at the TV locations. Install faceplates level and align to adjacent outlet faceplates.

3.06 MODULAR PLUG TERMINATED LINK]

A. Provide 8-pin modular plugs for the direct termination of 4-pair cables as identified above.

3.07 PATCH PANELS

A. Coordinate location of termination devices in the communication room equipment racks with the coordinated 27 11 00 Shop Drawings prior to commencement of work.

B. Coordinate the location of new termination devices installed in the existing equipment racks with the Owner prior to commencement of Work.

C. Provide 8-pin modular patch panels in the communication rooms for the termination of 4pair cables installed. Mount the patch panels into the equipment racks. Provide patch panels complete with Outlet ID designation strips.

D. Provide bulkhead panel in the communication rooms to mount 8-pin modular connectors for the termination of the 4-pair cables installed. Mount the patch panels into the equipment racks. Provide panels complete with Outlet ID designation strips.

E. Provide horizontal wire management panels in the equipment racks in the communication rooms on top of, in between and below the 8-pin modular patch panels installed in the equipment racks.

F. Provide lacer bars behind the patch panels to support the cables entering the patch panels.

3.08 PATCH AND EQUIPMENT CORDS

A. Provide for Owners use, category 6, 8-pin-modular-to-8-pin-modular patch cords for use in communication rooms.
   1. Manufacturer: Match the manufacturer of the patch/equipment cords with the manufacturer of the 8-pin modular connectors.
   2. Length: 4 feet, 6 feet, 8 feet and 10 feet. Coordinate the exact quantity of each length with the Owner.
   3. Color:
      a. Standard Data = White

b. Wireless = Green
c. Security = Black

3.09 IDENTIFICATION

A. Provide identification labels that are in accordance with the approved cable termination schedule.

B. Room numbers shown on the Drawings are not the final room numbers. Validate the final room numbers with the Architect prior to use in creating termination schedules, cable identification labels, cable record drawings, O&M documentation and cable test reports.

C. Provide machine-generated labels on cables in black uppercase lettering on a permanent adhesive, white label stock, covered with a permanent water-resistant sealer. Place labels on both ends of each cable and no more than 6 inches from the point at which the cable is broken out into individual copper pairs or strands from the connector or termination block or patch panel. Install labels so that the labels are parallel with the cable. Install labels so that labels are readily visible. Do not label cables with hand lettered labels.

D. Provide machine-generated labels on faceplates with the cable ID, in uppercase lettering. Label shall be of a contrasting color to the faceplate color. Do not label cables with hand lettered labels.

E. Provide machine-generated labels on patch panels with the equipment rack or cabinet ID and the rack unit position in uppercase lettering. Do not label devices with hand lettered labels.

F. Provide machine-generated label on patch panels with the cable ID and port number in uppercase lettering. Do not label devices with hand lettered labels.

G. Replace labels if at any time during the project, the label becomes illegible or is removed.

3.10 FIRESTOPPING

A. Provide Firestopping systems as rated walls and floors.

B. Comply with requirements in Division 07, [Section 078413 "Penetration Firestopping"].

C. Comply with TIA-569 “Firestopping".

D. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.11 FIELD QUALITY CONTROL

A. Provide an updated cable test plan submitted and approved as part of the Submittals process. Refer to article 1.02.D.2.

B. Notify the Architect, Owner and Engineer a minimum of 5 days in advance of the commencement of cable testing so that they can meet the cable tester at the site to observe the tester setup and the initial testing of cables.

C. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch/equipment cords, and labeling of components. Do not test cables until final dressing and labeling of the cables are in place.

D. Use testers that have been factory recalibrated within the last 12 months.

E. Use testers with current test firmware installed within.

F. For modular plug terminated links, use a Permanent Link Adapter on the Main Unit and a Patch Cord Adapter on the Far End or Remote Test Equipment. Do not use Channel adapters.

G. Comply with TIA 1152 Field Test Standard.

H. Perform inspections and permanent link tests and prepare test reports for 4-pair cable.
   1. Use a UL level 4 field test instrument.
   2. Use test instruments meet or exceed applicable requirements in TIA-568. Perform tests with a tester that complies with performance requirements in Annex I, complying with measurement accuracy specified in Annex H. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   3. Set the tester to the specific cable performance parameters as identified by the cable manufacturer for the specific cable being tested. Do not use generic cable test settings.
   4. Set test to reject Pass* (star) results.
   5. Test parameters for category 5e, 6 and 6A cables:
      a. Wire Map.
      b. Length.
      c. Propagation Delay.
      d. Delay Skew.
      e. DC Loop Resistance.
      f. DC Resistance Unbalanced Within a Pair.
      g. DC Resistance Unbalanced Between Pairs.
      h. Insertion Loss.
      i. Return Loss.
      j. NEXT (Near-End Crosstalk).
      k. PS NEXT (Power Sum Near-End Crosstalk).
      l. ACR-N (Attenuation to Crosstalk Ratio Near-End).
      m. ACR-F (Attenuation to Crosstalk Ratio Far-End).
      n. PSACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End).

o. PSACR-F (Power Sum Attenuation to Crosstalk Ratio Far--End).
p. TCL (Transverse Conversion Loss).
q. ELTCT. (Equal Level Transverse Conversion Loss).
r. Shield path.

6. Additional test parameters for category 6A cables:
   a. PSAACR-F (Average).
   b. PSANEXT (Average).
7. Test category 5e cables and conductors from 1 to 100 MHz with a tester that complies with TIA 1152 performance requirements in TIA-568, Level II. Include tests for longitudinal or transverse conversion loss.
8. Test category 6 cables and conductors from 1 to 250 MHz with a tester that complies with TIA 1152 performance requirements in TIA-568, Level III. Include tests for longitudinal or transverse conversion loss.
9. Test category 6A cables and conductors from 1 to 500 MHz with a tester that complies with TIA 1152 performance requirements in TIA-568, Level IIIE. Include tests for longitudinal or transverse conversion loss.
10. Test directly terminated cables with a field plug test adaptor with a plug on one end and a modular connector on the end patch cord adapter on the tester.
11. Provide evidence of testing apparatus has been calibrated within the last 12 months.
12. Provide evidence of replacement of consumable testing apparatus, including modular jacks, per the tester manufacturer's recommendations.
13. Provide evidence that the testing apparatus software or firmware has been updated to current revision/version.
14. Perform permanent link tests for cable length, insertion loss, near-end crosstalk loss, power sum near-end crosstalk loss, equal-level far-end crosstalk loss, power sum equal-level far-end crosstalk, return loss, propagation delay, and delay skew. Performance shall comply with minimum criteria in TIA-568.

I. Test Reports:
   1. Document test data for each measurement, including:
      a. Test parameters identified above.
      b. The overall Pass evaluation of the link-under-test.
      c. The date and time the test results were saved in the memory of the tester.
      d. The identification of the customer site as specified by the Owner.
      e. The name of the test limit selected to execute the stored test results.
      f. The name of the personnel performing the test.
      g. The version of the test firmware and the version of the test limit database held within the test instrument.
      h. The manufacturer, model and serial number of the field-test instrument.
      i. The adapters used.
      j. The factory calibration date.
   2. Provide a summary report that is formatted consistent with Table 10.1 in BICSI TDMM stating that cables meet the associated category performance requirements.
   3. Provide a link to tester manufacturer’s website to access cable test results.

4. Provide a printed report for each individual cable that tests within the instrument tolerance band for any parameter, i.e., for any parameter that would not pass if the instrument tolerance were taken as worst case.
5. Provide a USB Flash Drive containing the cable test reports in the PDF format.
6. Provide a USB Flash Drive containing the individual cable test reports in the native file format of the test instrument(s). Provide the software for the Owner's unlimited use in inspecting and printing test summary and individual cable test results.

J. Remove and replace cabling where test results do not comply with specified requirements. Retest and inspect cabling to determine compliance of replaced or additional work with specified requirements.

K. Upon review of the results of the completed tests, the Owner/Engineer reserves the right to witness the retesting of up to 10 percent of the installed cables, utilizing the Contractor's tester and the Contractor's labor. Retesting of cables shall stop when retested cables match the printed results.

L. After the installation is complete, in addition to any other required testing as described herein, and at such times as the Owner/Engineer directs, the Contractor shall be present while the Owner conducts an operating test for approval. The installation shall be demonstrated to be in accordance with the requirements of this specification. Any defects revealed shall be corrected promptly at the Contractor's expense and the tests performed again.

M. Provide test results to the Manufacturer for the processing of the performance warrantees afforded to the Owner.

3.12 CLEANING

A. Cover patch panel ports with dust proof barriers until acceptance by Owner.

3.13 CERTIFICATION & WARRANTY

A. Submit required drawings and cable test results to the manufacturer to secure System performance warrantees.

B. Provide a manufacturer's "Permanent Link" performance warranty of TIA 568 category 6, cables for a minimum period of, twenty-five years, from Owner acceptance of the completed system. Where a manufacturer's warranty is longer than, twenty-five years, offer the longer warranty.

C. The Permanent Link Performance Warranty shall be issued and signed by the Component Manufacturer (not the cable installation company) and shall list the Owner as the holder of the warranty.

D. The Permanent Link Performance Warranty shall cover the testing and replacement, including labor and material for "Permanent Link" components.

END OF SECTION

SECTION 27 41 16 – INTEGRATED AUDIOVISUAL SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, programming, licensing, testing and operation of an integrated audiovisual systems and equipment.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 27 41 16.10 Audiovisual System Systems and Equipment List.

C. ANSI/AVIXA V201.01:2021 - Image System Contrast Ratio.

D. ANSI/AVIXA S601.012021 - Audiovisual Systems Energy Management.

E. ANSI/INFOCOMM 10:2013 - Audiovisual Systems Performance Verification.

F. INFOCOMM F501.01:2015 - Cable Labeling for Audiovisual Systems.

G. ANSI/INFOCOMM V202.01:2016 - Display Image Size for 2D Content in Audiovisual Systems.

H. AVIXA RP-C303.01:2018 - Recommended Practices for Security in Networked AV Systems.

I. ANSI/IES/AVIXA RP-38-17 - Recommended Practice for Lighting Performance for Small to Medium Sized Videoconferencing Rooms.

J. AVIXA F502.01:2018 - Rack Building for Audiovisual Systems

K. AVIXA F502.02:2020 - Rack Design for Audiovisual (AV) Systems Standard

L. ANSI/INFOCOMM A102.01:2017 - Audio Coverage Uniformity in Listener Areas

M. NFPA 70, National Electrical Code, as adopted and amended by the local jurisdiction

N. IBC, International Building Code as adopted and amended by the local jurisdiction.

1.03 SUMMARY

A. Section Includes:
   1. Video equipment performance requirements.
   2. Infrastructure performance requirements.
   3. Basis-of-Design equipment list.

1.04 SYSTEM DESCRIPTION

A. Responsibilities of this section include
   1. Provision of complete and working systems as described in the project documents and drawings.
   2. Complete integration with systems, architectural features and equipment provided by others.
   3. Generation of submittals and documentation as described in the project documents and drawings.
   4. Provision and on-site installation of subject systems, including equipment, cabling, furniture, interfaces, infrastructure and appurtenances as required to deliver a complete system.
   5. Coordination with Owner for staging, cleaning, refurbishment and delivery of Owner furnished equipment.
   6. Coordination with general Contractor, Owner, audiovisual systems consultant and other disciplines.
   7. Initial adjustment of the systems and provision of test equipment for system checkout and acceptance tests.
   8. Training in the operation and maintenance of the systems for personnel designated by the Owner Space Description provided on the contract drawings.

1.05 ACTION SUBMITTALS

A. Factory certifications of contractor’s active personnel. Refer to section 1.4 for qualification submittal requirements. Contractor is responsible to notify the Architect of any personnel changes resulting in a loss of qualifications and provide a plan of action and timeline to reinstitute active personnel with the required factory certification. Upon reinstitution of active personnel, contractor is responsible to reissue an action submittal.

B. Manufacturer’s Instructions:
   1. Application conditions and limitations of use stipulated by the manufacturer.
   2. Installation manuals.

C. Product Data:
   1. System data.
   2. Materials list.
   3. Technical data (cut sheets) for on each component, including dimensions, finishes and weights.
   4. Where product datasheets show multiple items, options, or accessories, indicate on the datasheet the particular item/options/accessories that will be provided

D. Shop Drawings:

1. Description of system operation.
2. Network connections and network bandwidth requirements.
3. Coordinated reflected ceiling plans.
4. Source switching diagrams.
5. Single line/system block diagrams showing equipment and detailed connections between components. Include designators for equipment and cabling runs to correspond with those in floorplans.
6. Scaled floor plans with equipment, cabling, conduits, and back boxes. Indicate cabling quantities and types and pathway quantities and sizes.
7. Scaled reflected ceiling plans with equipment, cabling, conduits, and back boxes. Indicate cabling quantities and types and pathway quantities and sizes.
8. Scaled and dimensioned drawings of custom assemblies, including I/O panels, control panels, mounting structures, furniture, equipment racks and riggings.
9. Layouts/elevations of equipment cabinets and racks.
10. Electrical power loads and receptacles requirements for devices and equipment cabinets and racks.
11. Drawings of touchscreen/user interface pages and popups, indicating functionality of all buttons and logical links between pages/popups.
    a. Overview/flowchart for the proposed layout and architecture of the control interface.
    b. Annotated screenshots of all proposed pages, indicating functions for each button. Indicate which pages are accessible to general users and which are accessible only to technicians/authorized users. Provide a description of system behavior during standby, startup, and shutdown
    c. Fusion list of attributes to be incorporated into the management software.

E. Plans, elevations, diagrams, details, and attachments to other work, including rack elevations, custom plates, labelling, and finishes.
   1. Detail equipment assemblies and indicate dimensions, method of field assembly, and lo- cation of each component.
   2. Wiring Diagrams: For power, signal, and control wiring. Identify input/output terminals to facilitate installation, operation, and maintenance.
   3. List of attributes to be incorporated into the management software.

F. System Sequence of Operations:
   1. For each type of room, a description of how the system and its devices will be programmed, controlled, switched and used by the end user and managed by system mangers:
      a. Computer/laptop video display.
      b. Video/audio source switching.
      c. Programmed sound amplification.
      d. Presenter voice amplification.
      e. Assisted listening.
      f. Video conference near end.
      g. Video conference far end.

G. Documentation:
   1. Software license description.
   2. Software license list, including quantities provided and duration of authorization

H. Deferred Submittals:
   1. Installation plan and schedule.
   2. Training plan and schedule.

1.06 CLOSEOUT SUBMITTALS

A. Comply with close out submittals as per Section 27 05 00 - Common Work Results for Communication Systems.

B. Project Record Documents
   1. Record actual information of the installed Work.
   2. Floor plans and reflected ceiling plans identifying final locations of equipment, components and devices, cabling, and cable pathways. devices, devices IDs and raceway routing.
   3. Cable termination schedules.
   4. System sequence of operations.
   5. System programming manual/sheets.
   6. Component programming manual/sheets.
   7. Test procedures and results.

C. Operation and Maintenance Manuals:
   1. Job name, completion date, and names and contact information of Owner, Architect, Engineer, and Contractor. Operation and Maintenance manual shall include.
   2. Operation instructions for components of the system as a whole and each component in detail. Include software and hardware operation and programming. Write manuals to aid in training of new system operation personnel and as a guide in clarifying operational procedures.
   3. System operation instructions for the installed system.
   4. Product datasheet.
   5. Manufacturer’s operation manuals for installed equipment.
   6. System block diagrams.
   7. List of equipment serial numbers.
   8. List of consumable parts and contact information for ordering spares.
   9. Maintenance program and service instructions for components of the system as a whole and each component, function and operation in detail. Manuals shall include illustrations, mounting instructions, wiring diagrams, parts lists, operating

instructions and a trouble-shooting chart for the system, including a list of troubles, causes and recommended remedies.
10. Video recording of Owner training session(s).
11. Custom code created for the project, in uncompiled and editable format

D. Certificate of acceptance testing by the Owner.

E. Warrantees and warranty information, including warranty contract and contact information for engaging warranty service from the Contractor responsible for the work of this section, and manufacturer warranty information for installed equipment.

1.07 CONTRACT DRAWINGS

A. Coordinate back box and camera mounting requirements with system manufacturer/supplier. Refer to the Architectural drawings to understand wall and ceiling construction details. Notify Architect prior to installation if conflicts occur between:
1. Back box depth and wall thickness.
2. Wall construction.
3. Back box location.
4. Ceiling construction.

B. DELIVERY, STORAGE, AND HANDLING
1. Protect material from the entrance of dirt, dust, moisture, and debris

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer:
1. Factory-authorized dealer for the major components specified system with a minimum three years documented experience.
2. Factory certified for the programing of installed equipment, including control systems, DSPs, encoders, decoders, etc. The following certifications are required:
3. Have at least one systems technician certified by AVIXA as a Certified Technology Specialist – Installation.
4. Licensed, bonded, and insured to perform this work in the project location.

1.09 COORDINATION

A. Confirm exact installation location of devices with Architect and Owner prior to rough-in, including, but not limited to equipment installed in front of house spaces, equipment installed in custom assemblies, and equipment installed or routed through millwork / casework.

B. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including, but not

limited to, light fixtures, HVAC equipment, fire-suppression system, and partition assemblies. This includes coordination to confirm moving objects have a clear path of travel and confirmation that projected image paths are clear from obstruction.

C. Refer to the Architectural drawings for wall elevations, wall and ceiling design details and reflected ceiling plans.

D. Coordinate the installation of wall, ceiling, millwork, and podia mounted devices and components with the Architect.

E. Coordinate the location of wall, ceiling, millwork, and podia mounted devices and components with the Architect.

F. Coordinate finishes with Architect for exposed devices including speakers, wall- plates, etc.

G. When installing 24” square speakers in the space of 24” by 48” tile, coordinate requirements for additional sections of ceiling system T-Bar with The Architect.

H. Coordinate the location of wall, ceiling and podia mounted devices and components electricals connection with the Division 26 Work.

I. Coordinate requirements for 4-pair network cables/patch cords, color schemes, to connect with devices and equipment with the Work 27 15 00 Communication Horizontal Cabling.

J. Coordinate nomenclature and labeling scheme of enclosures, devices, components and cable devices with the Architect and Owner.

K. Coordinate media link control button programming and set up with the Architect and Owner for their preferred appearance, programming, and sequence of operation.

L. Coordinate the application and registration of software licenses with the Architect and Owner.

1.10 WARRANTY

A. The warranty shall include labor and equipment to maintain the integrated system in full operation for a period of one year for hardware from the date of final system acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. UL listed.

B. Equipment powered by 120V AC, single phase circuits.

C. Unless otherwise noted, equipment accessories shall be manufactured by the manufacturer of the equipment that they accessorize.

2.02 VIDEO PERFORMANCE SPECIFICATIONS

A. Fixed Lens Projector
   1. Acceptable Manufacturer
      a. Optoma ZW403
   2. Performance Requirements
      a. Type: Laser DLP
      b. Operation Hours: 30,000 Hours
      c. Resolution: 1280 x 800
      d. Minimum Lumens: 4,500
      e. Aspect Ratio 16:10
      f. Pole Mount

B. Projector Screen
   1. Acceptable Manufacturer
      a. Da-lite
      b. Drapper
   2. Performance Requirements
      a. Type: Motorized tensioned
      b. Color: Matte White
      c. Aspect Ratio: 16:10
      d. Black top drop: 12”

C. Receiver
   1. Acceptable Manufacturer
      a. Hall Technologies DSCV-70-RX
   2. Performance Requirements
      a. Type: 4K @ 60Hz
      b. HDBT 2.0
      c. RS232

D. Transmitter / Wall Plate
   1. Acceptable Manufacturer
      a. Hall Technologies DSCV2–70–TX-US
   2. Performance Requirements
      a. Type: 4K @ 60Hz
      b. HDBT 2.0
      c. USB-C
      d. (2) HDMI Ports

E. Amplifier
   1. Acceptable Manufacturer

a. Hall Technologies AMP-7040
2. Performance Requirements
a. Type: 70V Amp
b. RS232

F. Speakers
1. Acceptable Manufacturer
a. Belden
b. Boden
2. Performance Requirements
a. Type: 2’ x 2’ Tile Speakers
b. Suspended

G. Ceiling Box
1. Acceptable Manufacturer
a. Chief CMS492
b. Equal
2. Performance Requirements
a. Type: 2’ x 2’ Ceiling box
b. Suspended

2.03 EQUIPMENT MOUNTING

A. Provide mounting hardware as required for a finished installation of all equipment, including speakers, projectors, flat panel displays, rack-mounted equipment, control panels, and others. Where mounting hardware is not scheduled, it is nonetheless assumed to be included in the bid documents. Provide accessories for equipment racks as required for a complete installation, including power distribution and covers

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing cable and equipment and adjusting equipment.

B. Keep items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures throughout the life of the project.

C. Protect equipment from damage until their handoff to the Owner.

D. Examine the areas to receive the Work (walls, ceilings, floor, podia) and the conditions under which the Work would be performed. Identify damaged items and provide a list to the Architect prior to the commencement of Work.

E. Coordinate how and where podia, device, components, cables, connectors, faceplates will be installed prior to commencement of Work. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work.

F. Provide requirements for network access, IP addresses, MAC addresses with the Owner a minimum of 3 weeks in advance of required network access.

G. Materials and equipment installed under the work of this section must be produced by manufacturers with a minimum of 5 years' experience, and whose product literature demonstrates compliance with this section and the referenced codes and standards.

H. Manufacturers and model numbers used in the basis of design are indicated in the audiovisual equipment schedules. Unless otherwise noted, specified equipment is the basis of design and not intended to indicate sole sourcing of equipment. See below for equipment substitution requests.

I. Materials and equipment provided shall be new and meet or exceed performance requirements of those listed in the audiovisual equipment schedules.

J. If specified material or equipment has reached end of life at the time of procurement, Contractor shall provide current equivalent model.

K. Interface and coordinate the work of this section with that of other trades and examine drawings and specifications of other trades including mechanical, electrical, telecommunications, architectural, and structural for construction details and coordination.

L. Confirm exact installation location of all devices with the Owner / Architect / interior designer prior to rough-in, including, but not limited to equipment installed in front of house spaces, equipment installed in custom assemblies, and equipment installed or routed through millwork / casework.

M. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, light fixtures, HVAC equipment, fire-suppression system, and partition assemblies. This includes coordination to confirm moving objects have a clear path of travel and confirmation that projected image paths are clear from obstruction.

3.02 PREPARATION

A. Obtain system device programming templates from the Manufacturer(s). Coordinate programming parameter options with the Architect and Owner prior to programming.

B. Schedule a meeting(s) with Architect and Owner:
   1. Present project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up the system and system and device software.

2. Confirm the exact location of devices.
3. Confirm the system of operation for each system and device and component.
4. Coordinate how devices and rooms shall be controlled.
5. Coordinate how system shall be integrated.
6. Coordinate requirements to interface to videoconferencing systems and applications.
7. Coordinate software and license requirements and acceptance.
8. Coordinate default system and devices logins and passwords, and how they will be changed to Owner logins and passwords.
9. Coordinate network switch port requirements to connect devices into the network.
10. Coordinate device network address requirements.
11. Coordinate cable and device naming and labeling nomenclature.
12. Review system sequence of operations.

C. Record and share decisions for approval and acceptance by the Architect and Owner.

3.03 NETWORKING

A. Where Owner provided active and passive networking equipment is used as a part of the audio- visual installation, coordinate with Owner's representatives to ensure said networking equipment meets or exceeds specifications and is configured as required by the manufacturers of the audio- visual equipment that will reside on the network.

3.04 INSTALLATION

A. Coordinate finishes with Architect for exposed equipment, including speakers, wall-plates, etc.

B. Provide plenum rated cable and devices for installation of cable, devices, and components in ceiling areas.

C. When installing cable in a conduit, label both end s of the conduit noting the location of the other end.

D. If a pull cord is missing from a conduit, notify the installer of the 27 05 28 Conduit and Back Boxes for Communication System Work to have it installed.

E. When installing cable in a conduit, leave the pull cords in place after installing the cable.

F. Provide wall mount enclosures for installation of devices and components on walls. Provide grommeted knockouts inside of enclosure to allow passage of cables and cords

G. Provide ceiling tile mount enclosures for installation of devices and components in ceiling areas. Coordinate location and interconnection of power modules with the installation of power conductors and conduits.

H. Provide surface mount back boxes for installation of devices in podia.

I. Provide wall mounted back boxes for installation of devices on walls.

J. Provide accessories for equipment racks as required for a complete installation, including power distribution and covers.

K. Provide mounting hardware to secure equipment, components, and devices, including speakers, projectors, flat panel displays, rack-mounted equipment, control panels, and others.

L. Secure equipment and devices with permanent hardware adequate to support the equipment with a 3x weight multiplier safety factor.

M. Provide bracing for seismic activity as required by the Authorities Having Jurisdiction.

N. Provide accessories, backboxes, pathways, mounting hardware, decorative trim, escutcheons cabling, and ancillary equipment to provide a complete and functioning system.

3.05 CABLING

A. When wiring within an enclosures, bundle, lace, and train cables to terminal points with only the necessary excess and without exceeding manufacturer's limitations on bending radii. Provide proper cable slack and management within slide-out and rotating racks to allow for maintenance access while system is still operational.

B. Provide color-code cables/conductors and provide machine printed labels as identified herein to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Provide complete termination of conductors at outlets/connectors and terminals. Do not leave conductors unterminated.

D. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, and terminals.

E. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cables that are damaged during installation and replace it with new cable.

F. Maintain maximum separation from line voltage conductors. Where line voltage conductors must cross signal cabling, cross at right angles.

G. Separate line-level, speaker-level, and power wiring runs Install in separate raceways or, where exposed or in same enclosure, separate by at least 4 inches, ordered such that voltage differentials in adjacent cable runs are minimized. Separate other audio-video equipment conductors as recommended by equipment manufacturer.

H. When wiring within an enclosures, bundle, lace, and train cables to terminal points with only the necessary excess and without exceeding manufacturer's limitations on bending radii. Provide proper cable slack and management within slide-out and rotating racks to allow for maintenance access while system is still operational.

I. Provide patch cords/cable to provide a fully functioning system.

3.06 WIRELESS SYSTEMS

A. Confirm frequency range of specified wireless systems and equipment is appropriate for local regulations and is free from interference. Coordinate licensing for wireless systems as required.

B. Where multiple wireless systems are present, coordinate frequency ranges to prevent interference between systems.

C. Provide remote antenna(s), mounting, cabling and appurtenances as required for wireless transmitters/receivers as needed to ensure wireless system performance is free from dropouts, bad reception, static, and interference.

3.07 PROGRAMMING.

A. Program the system and controllers based the requirements coordinated and confirmed at the Preparation Meetings with Architect and Owner.

3.08 CUSTOM SOFTWARE / USER INTERFACE

A. Provide a system user interface (UI) that is consistent for all systems, even where control systems/panels from multiple manufacturers may be provided.

B. Provide color printouts of all UI pages and popups for review. Coordinate with Owner for audio- visual control system UIs, including Owner’s branding.

C. Obtaining final approval in wiring and signed from the Owner for control system UI screens.

3.09 LABELING

A. Provide cable labels corresponding with cable schedule and shop drawings.

B. Label cabling in accordance with AVIXA F501.01:2015.

C. Provide permanent machine printed labels to each end of power cables.

D. Provide permanent machine printed labels to each end of system cables.

E. Barcode labels are acceptable if accompanied by a text label readable without machine assistance. Text height shall be minimum 2.5mm, and label shall be within 1-12 inches of termination, the end of unterminated cable, or the exit of cable jacketing or strain-relief.

3.10 LICENSES

A. Register, secure and provides licenses to the Owner to provide a fully functioning and integrated system.

3.11 FIRESTOPPING

A. Provide Firestopping systems as rated walls and floors.

B. Comply with requirements in Division 07 "Penetration Firestopping."

C. Comply with TIA-569 "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.12 FIELD QUALITY CONTROL

A. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all devices and components.

B. Check programming scripts match Owner requirements.

C. Use manufacturers' maintenance or installation manuals for initial set up to tune the test image and sound spectrum.

D. Check for proper polarity of speakers.

E. Adjust images setting for balance, alignment and to free of hum, distortion, and artifacts.

3.13 SYSTEM PERFORMANCE CRITERIA

A. Conduct tests and measurements in accordance with AV9000:2011 Quality Management System for the Audio-Visual Technology Industry and ANSI/Infocomm 10:2013, AV Systems Performance Verification to ensure acceptable system performance.

B. Measure and document system performance against the following minimum criteria. Where system performance criteria are not met, take corrective action as required to bring system performance into compliance with criteria listed here and in the referenced

performance documents. Where criteria listed below and those in the referenced performance documents are in disagreement, the more stringent are in effect.

1. Audio
    a. Ambient Noise level (A weighted).
    b. Conference Rooms and enclosed offices: 42 dB, or as specified by acoustic consultant.
    c. Common areas, open office areas: 50 dB, or as specified by acoustic consultant
    d. Voice reinforcement and program audio signal levels: ≥ ambient noise level + 25 dB.
    e. Steady state sound coverage uniformity, measured with random noise signal in 4000 Hz octave band at seated ear height: ≤±3 dB at all conference room seats or at 10-foot grid spacing in open areas (Lobby, On Site Off Site, etc.).
    f. Head room level: 10 dB.
    g. Audio electrical SNR: ≥60 dB.
    h. Audio system output level variance: ≤±1 dB.
    i. Program audio signal sources should be balanced at the input stage to generate a level variance not to exceed ±1 dB.
    j. The system under test shall produce a flat frequency response (+/-0.5dB) from 20 Hz to 20 kHz.
    k. Speech Transmission Index: ≥0.66.
    l. Audio power amplifier channels shall not be loaded beyond their rated capacity.
    m. Voice reinforcement shall be stable. No audible feedback is acceptable.
    n. Balance/adjust audio and videoconferencing microphone gains and lobes such that standard voices (60dB, 1m) at each seated conferencing position produce a signal level variance of ≤±3 db.
    o. Audio only system latency: ≤2 ms.
    p. Total Harmonic Distortion: <1%.
    q. Acoustic echo cancellation: no perceptible echo (>55dB cancellation).
2. Video
    a. Display resolution: per specified displays in Display Schedule.
    b. Camera resolution: per specified cameras in Audiovisual Equipment Schedules.
    c. Display luminance: ≥500 nits.
    d. Digital displays shall be free from artifacts and faithfully display program content.
    e. Confirm optimal brightness, contrast and color in displays using SMPTE source with PLUGE display.
    f. Where multiple displays are visible in the same area, demonstrate color consistency throughout.
    g. Confirm that displayed images are free from visible distortion.
    h. 0-pixel failures per display.
    i. Confirm even illumination across displays. No location shall be measured to be greater than +10% or -5% the average illumination.

j. Test all digital video signal chains to ensure HDCP is carried through, enabling display of protected content at all locations, U.O.N.
k. Audio/video system latency (lip sync) shall not exceed +20 ms/-40ms.

3. Control, Power, Compatibility, Other
   a. Confirm the system components are powered up and down in sequence. Audio power amplifiers shall power up last and power down first. Control processors should never power down.
   b. Confirm the manufacturer's recommended cable bend radii are not exceeded.
   c. Demonstrate audio and video teleconferencing compatibility with all anticipated far-end hard and soft codecs, including, at a minimum, Teams, Zoom, Bluejeans, Webex, Jabber, SIP/H.323, etc.
   d. Confirm the control system performs listed functions as indicated and described in the contract documents while remaining synced with audiovisual system components and external system hardware and software
   e. Coordinate with Owner and manufacturers to ensure manufacturer logos are not visible on installed digital displays
   f. Confirm the audio systems will mute program content in response to input from life safety and emergency paging systems.
   g. Control system latency, as measured from user input to user feedback or completed system operation shall not exceed 100 ms.

3.14 STARTUP SERVICE

A. Perform startup service.
   1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
   2. Complete installation and startup check according to manufacturer's written instructions.
   3. Conduct system verification tests to ensure system performs as intended. Reference "Infocomm Audiovisual Systems Performance Verification Checklist," available at http://www.infocomm.org/cps/rde/xbcr/infocomm/CAVSP_Checklist.pdf. Indicate PASS/FAIL/NOT APPLICABLE for listed criteria and include as System Verification Test Report in Operation and Maintenance submittal. Reference section 1.

3.15 ACCEPTANCE TESTING

A. At completion of startup service and acceptance of system verification test report, schedule site visit with Architect and Owner.
   1. Make available the following during acceptance testing
      a. Final 'as-built' drawings, shop drawings, floor plans, block diagrams, and equipment manufacturer's operation/setup manuals
      b. Source and measurement media/equipment to demonstrate all functions of audio- visual systems

2. Adjust including physically re-mounting/re-aligning equipment, adjusting gain, equalization, control system GUI, etc.
3. Failed acceptance tests requiring rework which cannot be completed during the scheduled acceptance test visit will be grounds for non-acceptance and shall require additional acceptance testing at a future date to demonstrate compliance with the project documents.
4. Reimburse the Architect and Engineer for their time expenses for additional site visits due to acceptance test failures.

3.16 ADJUSTING]

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

3.17 DEMONSTRATION AND TRAINING

A. Conduct a walking tour of Project with the Architect and Owner. Describe function, operation, control, and maintenance of each component.

B. Assist the Owner in their testing of the activated system for control, signal routing, content image display and performance and sound performance.

C. Conduct a training session with the Owner during which programming, use, maintenance and operational aspects of the system, devices and components are described and demonstrated.

D. Use submitted operation and maintenance manual as reference during demonstration and training.

E. Provide a minimum of one 4-hour classroom training session(s) for the Owner’s systems operators and network managers at the Owner’s site. The sessions shall include the following.
1. Training outline, agenda and training material for (#) people.
2. System operation manuals.
3. System programming manuals.
4. Demonstrate system operations, management, features, and component programming.
5. Set up.

F. Demonstrate how to use, control, operate, adjust and maintain the system.

Record and provide to the Owner the recording on a USB flash drive or digitally.

3.18 WARRANTY

A. Complete registrations and proof of purchases required to activate the manufacturer's warranty.

B. Invoke manufacturer's warranties as necessary during the warranty period. Obtain Return-Merchandise-Authorization for shipping defective material back and receiving replacements materials.

3.19 CLEANING

A. Cover devices with dust proof barriers until acceptance by Owner.

END OF SECTION

SECTION 27 41 16 - INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Provisions of Division 1 apply to this section.

B. Section Includes:
1. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, set up, and testing of the Audio, Video and Control Systems work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, working systems. General design intent for this project is shown on the drawings and described in the specification.
2. All equipment requiring coordination with other trades must be tested and verified for proper operation. Contractor is fully responsible for the coordination and must resolve all conflicts with AV equipment that connect or interact with other systems.
3. If an operational function is specified that requires hardware or software to complete that specific function, then consider that software or hardware part of this specification. The cost of any omissions of software or hardware necessary to complete all operational functions outlined in this specification shall be borne by the contractor providing this system.
4. Design, engineer and provide complete means of support, suspension, attachment, fastening, bracing, and seismic restraints (hereinafter "support") of the Work of this Section, including future installed equipment, in accordance with local building codes and regulations. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Contractor shall obtain the services of an engineer licensed to perform this work within the state or jurisdiction it is to be performed.
5. The Contractor shall include all costs associated with structural engineering required by code for work in this section.
6. Use skilled mechanics that can return surfaces to the appearance of new work when modifying millwork.
7. Conduit and common back boxes including four square, pull boxes, junction boxes, etc. are supplied and installed by Division 26 Electrical Contractor. Connection panels that install in these boxes are supplied by AV Contractor.
8. Provide Power Over Ethernet switches and injectors where required.
9. Provide all cable and wire associated with this specification section and related documents.
10. All systems shall be completely installed with all the necessary interconnection, power supplies, patch cords, snakes, portable equipment cables and wiring to provide a fully functioning system.
11. The governing overall requirement for this project is a complete and functional system.
12. Include work not usually shown or specified, but necessary for proper installation and operation of the system or piece of equipment.

C. Products Supplied But Not Installed Under This Section

1. Loose equipment or products supplied but not installed shall be turned-over to the Owner immediately upon delivery. Contractor is to supply a signed statement of transfer of this equipment to the consultant for record. Client must sign this statement acknowledging receipt of this equipment.
2. Specialty floor boxes, back boxes including but not limited to Crestron, AMX, Extron, FSR, Steel City and speaker back boxes shall be provided to the General Contractor for installation.

D. Related Sections
1. Division 1.
2. Division 9.
3. Division 10.
4. Division 11.
5. Division 26.

E. Allowances
1. Refer to section 2.1.E for related requirements.

F. Measurement Procedures
1. Product quantity is as required. If a quantity is given, the Contractor will provide at least the given amount. Some products listed under this section may not be required to fulfill the obligations of the work.

1.02 REFERENCES

A. Comply with all applicable governing codes.

B. Comply with the following applicable organizations and standards:
1. AES Audio Engineering Society
2. ANSI American National Standards Institute
3. ASTM American Society for Testing and Materials
4. ATSC Advance Television System Committee
5. BICSI Building Industry Consulting Service International, Inc.
6. BTSC Broadcast Television Stereo Committee
7. CBC California Building Code
8. CEDIA Custom Electronic Design and Installation Association
9. EIA Electronic Industries Alliance
   a. RS-310-C: (ANSI C83.9) Racks, Panels, and Associated Equipment
   b. RS-453: Dimensional, Mechanical, and Electrical Characteristics Defining Phone Plugs and Jacks
10. ETL Electrical Testing Laboratories, Inc.
11. FCC Federal Communications Commission
12. ICIA International Communications Industries Association
13. IEC International Electrotechnical Commission
14. IEEE Institute of Electrical and Electronic Engineers
15. INCITS International Committee for Information Technology Standards
16. ISO International Organization for Standardization
17. ITU International Telecommunications Union
18. NAB National Association of Broadcasters
19. NCTA National Cable and Telecommunications Association
20. NEC National Electrical Code
21. NEMA National Electrical Manufacturers Association

22. NFPA National Fire Protection Association
23. NSCA National Systems Contractors Association
24. OSHA Occupational Safety and Health Administration
25. SMPTE Society of Motion Picture and Television Engineers
26. TASO Television Allocation Study Organization
27. TIA Telecommunications Industry Association
28. UL Underwriters Laboratories Inc.

1.03 DEFINITIONS

A. Definitions of Terms: The following definitions and conditions apply to each of the respective parameters and the measurements of those parameters, unless specifically stated otherwise:
   1. Frequency Response: The minimum acceptable frequency band over which the amplitude response is within 3 dB (or any specified range), or the specified limits of the response relative to the reference frequency (1 kHz for audio, 1.0 MHz for video) under design load conditions, at any operating level up to and including the specified maximum output while fully in compliance with all other performance specifications.
   2. Maximum Output Level: The minimum acceptable maximum signal output level (voltage, current or power) attained under design load conditions attained while fully in compliance with all other performance specifications.
   3. Harmonic Distortion: The maximum acceptable harmonic distortion measured at any operating level, up to and including the specified maximum output, with an applied sine wave signal of any frequency in the range of the specified frequency response.
   4. Audio Intermodulation Distortion: The maximum acceptable intermodulation distortion resulting from the introduction of 60 Hz and 7 kHz signals in a ratio of 4:1 under design load conditions at any operating level up to and including the specified maximum output level.
   5. Signal to Noise Ratio: The minimum acceptable ratio of signal to noise levels derived from broadband measurements under design load at maximum output over the entire range of the specified frequency response.
   6. Clipping Level: The minimum acceptable maximum level of signal applied to the device under design load conditions while fully in compliance with all other performance specifications.
   7. Sensitivity: The maximum acceptable level of input signal applied to the device that is necessary to provide the maximum output under design load conditions.
   8. Design Load: The load (in ohms) specified by usage of the particular device input or output.

B. Signal Levels: The following voltage levels shall be considered the standard operating levels for the particular circuitry, unless specifically noted otherwise (0.775 Volt = O dBu = O dBm for a 600 ohms terminated circuit):
   1. Microphone Circuits: -30 dBu or less.
   2. Audio Line Level Circuits: -30 dBu to +24 dBu; equivalent to -30 dBm to +24 dBm for a 600 ohms terminated circuit.
   3. Loudspeaker Level Circuits: More than +24 dBu.
   4. Video Line Level Circuits: 1.0 Volt, peak to peak composite signal.

C. Characteristic Impedances: The following operating impedances shall be considered to be the standard operating impedances for the particular circuitry, unless specifically noted otherwise:
   1. Microphone Circuits: 50-250 ohms source, 150-1500 ohms terminating, electrostatically and electromagnetically balanced to ground.
   2. Audio Line Level Circuits: 600 ohms maximum source, 600 ohms minimum. terminating, line to line, electrostatically and electromagnetically balanced to ground.
   3. Video Line Level Circuits: 75 ohms maximum source, 75 ohms minimum terminating to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.

1.04 SYSTEM DESCRIPTION

A. Design Requirements
   1. General
      a. The EMUSD Arroyo High School Theater audio-visual system.
      b. All audio processing functions for the system shall be implemented with Digital Signal Processing equipment (DSP). The system shall connect to the Local Area Network for monitoring. Functions provided by this system include but are not limited mixing, level control, automatic mixing, equalization, adaptive equalization, delay, routing, dynamics, filters, processors, presets, etc.
      c. The audio system shall include a DTMF module that will act as an interface between the paging system and the telephone system. Dialing a pre-defined sequence of numbers into the telephone will allow a zone or an all page to occur. The system will suppress background music during paging.
      d. Fire Alarm Interface: Sound System shall mute under zone control from the Project Fire Alarm System. Provide connection between fire alarm panel and audio system for automatic muting of signal upon trigger of alarm. Coordinate with work of Fire Alarm section.
      e. Infrastructure shall be provided for the installation of AV equipment that will be installed at a future date. This infrastructure shall be labeled to allow easy identification of these devices. Back boxes shall be labeled with Device ID. Conduit shall be labeled as follows: AV-CTRL = Control, AV-SPK = Speaker, AV-AUD = Audio, AV-VID = Video, AV = Both Audio & Video.
      f. An integrated web-enabled central control system shall be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.
   2. Sound Reinforcement
      a. The sound reinforcement system for the Theater shall provide natural, unobtrusive augmentation of the inherent acoustics in the space.
      b. The system shall be utilized for theatrical, instrumental music performances and presentations as required and to provide reproduction of electronic and pre-recorded program material. The audio system shall be controlled by either a designated operator at the front of house position, or remotely by a presenter or coordinator in the stage area.
      c. The main sound reinforcement system for the Theater shall include a stereo line-array speaker system arranged per the audio system drawings. Subwoofers will be provided as part of the line-array rig for extended low

frequency coverage. The Contractor is to field verify all speaker aiming angles before permanent installation of speaker clusters.

d. The audio processing equipment will provide automatic mixing of selected inputs for events where an operator may not be required.
e. The frontend of the digital audio distribution system utilizes a Dante network. The audio consoles, networked stage boxes and the Control Room computer workstation shall connect to this network. This system will provide the user with virtual patching allowing for flexible routing to and from any endpoint. Contractor to provide I/O routing matrix page at the Control Room computer workstation.
f. The main digital signal processor shall include a touch panel control located adjacent to the mixing console to allow control of the microphone preamps from the control room.
g. Microphone inputs shall be located throughout the Theater Orchestra Pit, stage, and various facility panels. Having multiple input locations will allow for flexibility in the number and location of microphones to serve different types of performances and to avoid long exposed cable runs.
h. A multi-channel wireless microphone system shall provide for individual use of belt pack and hand-held transmitters for theatrical and vocal performance.
i. A digital mixing console shall provide mixing and routing of all audio inputs. The console shall be located in the control room. The console shall feature provisions for onboard processing and effects. It shall include integrated Wi-Fi to allow control from IOS devices. The console shall include on board effects processing. The Contractor shall provide factory training for the console and its auxiliary features for the client's user group.
j. Powered audio monitors shall be provided adjacent to the mixing console.
k. To provide the best possible auditory experience for audience members with certain types of hearing impairment, and to satisfy the requirements of the Americans with Disabilities Act, an IR wireless Assistive Listening system shall be provided. This system will transmit a mix from the sound system to headsets which may be checked out by audience members as needed.
l. The main audio system must mute when a signal from the campus wide paging is present in the auditorium. A signal from the campus paging system will mute the auditorium sound system to allow paging speakers to be heard. This feature shall be programmed in the main control processor to allow only priority pages to mute the system. Standard pages shall not mute the system.
m. The intercom system will be used by the production staff, show director, lighting director, sound system operator, lighting operators, orchestra conductor, and other personnel involved in rehearsals and productions. The intercom system shall provide a minimum of four channels. The main intercom station will be located in the Control Room. Connection points for belt-pack stations with microphone/headsets shall be provided at the sound and lighting operators' locations. Wall mounted stations with integral loudspeakers and microphones will be provided in the Schene Shop, Band Room, Choral Room, Dressing Rooms, and Drama Classrooms. Belt pack receptacles shall be provided as shown in the drawings.

3. Video System

a. The video projection system shall consist of a Laser type video/graphics projector with a 16:10 aspect ratio and native resolution of 2,560 x1,600.
b. The projection screen shall be sized per drawing with 16:10 aspect ratio and mounted as shown in the drawings.
c. Built-in video source equipment shall include a Blu-Ray / DVD player. An input for a laptop computer shall be provided at various locations on the stage and in the control room.
d. Automatic digital video scaling shall be employed to re-size the various image formats to fit the native resolution of the video projector.
e. All video and computer switching shall be accomplished with video switching equipment located in the main equipment rack and remotely controlled from the main control room.
f. A video camera shall be mounted in the Theater and used for monitoring and distributing a video feed of stage activity to the Control Room, lobby, and Dressing Rooms.
g. A video display located in the Lobby shall have the ability to display digital signage content. Digital signage players are school provided and installed by The Contractor, coordinate this effort.

4. Control System
   a. An integrated web-enabled central control system shall be used to control all aspects of the audio and video system's functions and signal routing. The system shall consist of touch screen panels located as per the drawings. The touch panels located on the stage area would allow presenters to control the speech reinforcement and video systems for events which do not require a full-time operator. This user interface will allow control of the overall volume of lectern microphones, source equipment transport and lighting presets.

B. Software Programming
   1. General
      a. Except when otherwise agreed in writing the client shall retain legal and beneficial ownership of all Intellectual Property, including source code, created by the Contractor, their employees, and sub-contractors.
      b. The Contractor must allow sufficient time for the programming of all software configurable audio, video and control systems. Contractors must evaluate the systems functional requirements and user interface and then allow time in their bid accordingly. The system description as well as the end user interview will provide the Contractor with the necessary information needed to proceed with the programming. Any questions as to the systems functional requirements must be sent in written RFI form to the Consultant. All programming schemes must be submitted to the Consultant for approval before programming starts. This includes the appearance of all user interfaces, touch panel layouts, preset and sub-preset information (acquired through client interviews), and speaker control schemes. The Contractor will also submit a narrative for the control system concept to the Consultant for approval. The Contractor is to interview the Owner and their representatives to acquire the necessary information needed to allow for the proper programming of this system. The Contractor, after interviewing the Owner, will then submit a written report stating his interpretation of the client's requirements for approval by Consultant. Only after the Client and Consultant have approved the

programming report may the Contractor proceed with the programming of this system.

c. All equipment that is connected to the Client's local area network and is configurable via the local area network must have its equipment software installed onto dedicated computers provided by the Client. The Contractor is to allot time to install and test equipment software onto a minimum of two of the Client's computers which are to be identified by the Client and/or Consultant. The computers shall be programmed to emulate user interfaces throughout the facility. The Contractor shall coordinate all software deployment over IP with the Client's Information technology department.

2. Control system minimum programming outlined below:
   a. The Contractor shall allot 8 hours for on-site control system programming with the Client's representative.
   b. The Control System in this project shall connect to the Client's Local Area Network (LAN). This connection will provide desktop computers control of the audio-visual system as well as make available remote troubleshooting via the internet. The Contractor shall provide time to install control system interface software on at least one desktop computers. Coordinate work with Client's Information Services personnel.
   c. Provide password protection to each control surface in this facility. Pushbutton panels shall be activated by holding the lower two buttons down for 5 seconds. Deactivation will automatically take place 120 seconds after control panel was last gestured. Touch panels shall be activated and deactivated by password. Upon start up a password dialog box shall be presented to the user to enter his/her password. Only after entering a password will the user have access to the system. The system shall be programmed to shut down automatically after being idle for a time to be specified by the user.
   d. All control panels shall be programmed with a technical user mode that allows technical personnel to access a second level of control. A push button volume adjust/source select control interface usually includes various sources that may be played into the zone under control. These sources enter a mixer in the DSP allowing control of both input and output of this mixer. Normal, user level, operation of volume control at a user interface shall permit only the output of the mixer to be controlled. This allows a user the ability to control the output of the mixer to raise and lower the volume of all source devices simultaneously. Pressing any of the source select buttons shall bring up a dialog box that will allow a technician to enter a password and allow technical personnel access to a second level of control functionality. This will permit a technician to balance levels at the inputs of the mixer when required. After sixty seconds of inactivity the panel will automatically default back to user level control.
   e. Touch panel layout design will conform to the InfoComm International "Dashboard for Controls" guidelines. Touch panel designs are to be custom to this project. Re-purposed touch panel designs are not acceptable.
   f. Technical users shall have the ability to access individual speaker zone controls via the touch panel interface.

g. The contractor shall provide a default audio level preset button, in the control system user interface, to allow a user or technician to recall all gain levels that were set when the system was commissioned.
h. Control Help File: Each touch panel will include a help file that will explain each layer of the touch-panel control scheme.
i. Control system shall utilize help desk software to provide:
    1) Real-time monitoring of:
        a) Control system.
        b) Device monitoring.
        c) System online status.
    2) Remote system diagnostics via Contractors help desk.
    3) Remote system control.
    4) Event scheduling.
    5) Fault reporting via email alert.
    6) Logging of help request.
    7) User access control via password protection.
    8) Event logging, report, and chart generation.
j. The help desk software shall be placed on the desktop computers of each audio-visual maintenance person as well as key personnel of the Client. The Contractor shall train maintenance and operations persons to use this software feature.
k. All serial controlled devices must have bi-directional communication with the control system. All control functions locally available on each device must be accessible via the remote-control system. All locally gestured control functions must mirror on the control system user interface. In other words, if a volume control is adjusted on a DSP interface that adjustment must register on the control interface.
l. Control system shall be used to power up and down connected equipment at control system start up and shut down.
m. The control system shall monitor the connected power amplifiers and report overheating that may occur.

3. Digital Signal Processor (DSP) minimum programming outlined below:
    a. A user-friendly graphical interface programmed by the Contractor will allow for easy operation of the system. This interface shall allow novice users the control of main system components without having to access the digital schematic diagram. These main system components will include master volume control, zone volume control, room combining, routing, switching, source-equipment level control and any other control necessary for the system to function properly from a user standpoint.
    b. When applicable contractor shall configure IGMP Snooping with a querier to mitigate Multicast issues.
    c. The main digital processor shall be programmed to act as the clock master for the system.
    d. All audio processing functions for the system shall be implemented with Digital Signal Processing equipment (DSP). The system shall connect to the Local Area Network for monitoring. Functions provided by this system include but are not limited to mixing, level control, automatic mixing, equalization, adaptive equalization, delay, routing, dynamics, filters, processors, presets, etc.
    e. Volume control must be applied to device inputs as well as mixer outputs. Each piece of source equipment shall have a volume control to allow input

level balancing. A main volume control and mute button will allow for overall adjustment of the composite mix.

f. DSP unit shall be programmed to route all input and output signal to the rack mounted audio monitor. This routing controller shall be labeled clearly identifying the input devices and output zones it controls. This control shall be accessible only from the touch panel in the main equipment room. Provide a separate page to allow this feature.
g. Provide automatic level control at the input of all line level source equipment.
h. Signal present indicators shall be placed on the graphical user interface to allow monitoring of all inputs and outputs to the audio system.
i. Meters shall be placed along strategic points in the signal chain to allow for monitoring signal level.
j. Schematic diagram shall be arranged so wire paths are easily traced. All inputs and output shall be clearly labeled.
k. Rooms combining of audio signal shall be accomplished through presets that control the various room arrangements. These presets shall include signal routing, level change, delay, combining and separation of the audio signal. Wall mounted control stations shall track each other while in a combine mode and provide individual control of rooms when separated.
l. The DSP system shall connect to the Local Area Network for control and programming.
m. The DSP system shall include levels of security for system operation and maintenance privileges.
    1) A first level of security shall be available to a user that has privileges which requires no password, limited to source select and volume control.
    2) A second level of security shall grant an operator privileges that include System shut down, run hardware diagnostics, access on line help and adjust settings. This is reserved for maintenance personnel.
    3) A third level of security shall grant supervisor privileges and allow all that is outlined above plus the ability to change system options and edit user list.
    4) A fourth level of security shall grant designer privileges and allow all that is outlined above plus the ability to modify the base file. This should be reserved to the AV contractor only.
n. The Contractor is to allow programming time for at least 5 different presets as directed by the Owner and their representative.
o. The Contractor shall allot 8 hours for on-site digital signal processor programming with the client's representative.

4. Complexity of Programming:
    a. It is required that the Contractor be experienced in programming systems this complicated. Contractors shall allow enough time in their bid to permit extensive programming of all software configurable audio, video and control systems to the requirements of the client and consultant. Contractor shall break out cost associated with programming of these systems for review by the Consultant. By submitting this bid, the Contractor agrees that they understand systems of this type and that all programming services are included to the satisfaction of the Client and Consultant. The Contractor further agrees that they will not make any claim

for additional monies because of misinterpretation of programming requirements.

C. System Performance Standards and Requirements (meet or exceed)
   1. Audio Systems:
      a. Electrical Performance; Source Input to Power Amplifier Output:
         1) Frequency Response (Equalizer flat): +/- 0.2 dB 20 Hz to 20 kHz.
         2) Total Harmonic Distortion (THD): Less than 0.05%, 20 Hz to 20 kHz, 4 ohms.
         3) Noise: At least -105 dB, 20 Hz to 20 kHz, referenced to input of +4 dBm.
         4) Crosstalk: At least -60 dB, 20 Hz to 20 kHz.
         5) Damping Factor: Greater than 500 (below 1 kHz)
      b. Electro/Acoustic Performance; Distributed Systems: 103 dB Consistent with devices specified herein.
         1) Equipment: Specified individually.
         2) Audio signal paths: Shall not degrade performance of connected equipment.
      c. NEC - Article 640: Audio Signal Processing, Amplification and Reproduction Equipment.
   2. Video Systems:
      a. Video signal system: ATSC 1.0 or 3.0, where applicable.
      b. Video signal paths: To EIA RS-250C short haul where equalized or fiber optic transmission, otherwise to the performance limit of the specified video cable.
      c. ANSI IT7.228 (ANSI Lumens): Measurement method for light output of fixed resolution video projection systems.
      d. ANSI IT7.228 (ANSI Contrast Ratio): Measurement method for the contrast ratio of fixed resolution video projection systems.
      e. JPEG: Joint Photographic Experts Group. Proposes and publishes video standards for Still Images.
      f. MPEG: Motion Picture Experts Group. Proposes and publishes video standards for Broadcast.
      g. EIA RS 170 & 170A The original specs for Monochrome and Color TV in the US. Has been replaced by SMPTE 170M.
      h. EIA 770-1: The US spec for Enhanced Component video, similar to ITU-R BT1197/ETSI 300 294 for PAL-Plus.
      i. EIA 770-2: The US specs for Standard Definition TV (SDTV) Baseband Component Video.
      j. EIA 770-3: The US spec for High-Definition TV (HDTV) Baseband Video.
      k. ITU-R BT.470: Harmonized spec for SDTV worldwide, including NTSC, PAL, and SECAM.
      l. ITU-R BT.601: Universal Sampling spec for SDTV and HDTV Broadcast Video. Similar to SMPTE125M.
      m. ITU-R BT1197/ETSI 300 294: Spec for PAL Plus Enhanced TV in Europe.
      n. SMPTE 125M: Similar to ITU-R BT.601.
      o. SMPTE 170M: Has replaced EIA RS 170A, color spec for NTSC.
      p. SMPTE 253M: RGB Analog Video Interface spec for SDTV Studio applications.
      q. SMPTE 274M: Component spec for 1920x1080 HDTV.
      r. SMPTE 296M: Spec for 1280 x 720 RGB and YPbPr Baseband Video. Similar to PAL Plus.

3. Data and Communications Systems:
   a. TIA/EIA 568-C series: Commercial Building Telecommunications Cabling Standard.
   b. ANSI J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
   c. Comply with ITU-T (International Telecommunications Union – Telecom) for video conferencing systems.
4. Control Systems:
   a. RS485 (TIA-485): Electrical characteristics of generators and receivers for use in balanced digital multipoint systems.
   b. RS232 (TIA-232): Interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.
   c. RS 422 (TIA-422): Electrical characteristics of balanced voltage digital interface circuits.

1.05 SUBMITTALS

A. General
   1. In addition to the requirements of Division 1, submit all materials for review arranged in the same order as the Specification, individually referenced to the Specification paragraph and Contract Drawing number. Submit 8 1/2" x 11" items bound in volumes and drawings in edge-bound sets. Submit all drawings on sheets of the same size.
   2. The Contractor is to provide two copies of each hardcopy submittal and an electronic format copy (Shop drawings must be submitted as .DWF. All other submittals shall be provided as .PDF). All submittals must be original files or documents, scanned copies will not be accepted.
   3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
   4. Should the Contractor proceed with the Work of this Section in the absence of submittals for such work submitted and returned with action "No Exception Taken" or "Make Corrections As Noted", the Contractor proceeds at the Contractor's sole risk.
   5. If the Contractor deviates from the design shown on the Contract Documents when preparing their shop drawings, the Contractor shall indicate with architectural style clouding, those deviations. The Contractor shall also submit with the Shop Drawings, a list of those deviations and substitutions, including the following:
      a. The deviation item number which shall also correspond to a number designation applied to each cloud on the shop drawings.
      b. Section of the specification that applies to these changes.
      c. The applicable shop drawing sheet number for each item.
      d. The corresponding audio-visual Contract Document sheet number for each item.
      e. A clear description of the deviation.
      f. The Contractor’s rational for the deviation (i.e. what benefit the deviation provides, why it is required, any cost impact, etc.).

B. Infrastructure
   1. Provide drawings indicating boxes conforming and non-conforming to Consultant’s AV drawings.

C. Product Data
   1. Manufacturer's Product Data
      a. Contractor is to submit submittal in electronic format (i.e. PDF)
      b. List of materials (i.e. Table of Contents) categorized by room type: For each item specified in PART 2, include:
         1) Drawing device ID code.
         2) Manufacturer.
         3) Model number.
         4) Listing: UL or other lab.
         5) Quantity.
      c. In sequence of List of Materials, provide a data sheet for each item, including all accessories marked for the proposed product.

D. Shop Drawings
   1. Field (Installation) Drawings: Collate in sequence:
      a. Contractor is to submit shop drawings in .DWF format.
      b. Drawing index/symbol sheet.
      c. Floor plans. At scale of Contract Documents. Show:
         1) Device rough-in boxes with ID number.
         2) Mounting height.
         3) Conduit size.
         4) Wire type.
         5) Wire fill.
      d. Sections/Elevations. At scale of Contract Documents:
         1) Mounting location reference to nearest gridline.
            a) Provide sections for each room containing AV equipment.
            b) Provide elevations for each wall in rooms containing AV equipment.
            c) Show all equipment, including speakers, monitors, projectors, podium, floor boxes, facility boxes, etc.
            d) Provide vertical dimensions referenced above finished floor to each piece of equipment.
            e) Provide horizontal dimensions reference to gridlines.
      e. Enlarged Plans. At scale of Contract Documents or larger as required for trade coordination. Show:
         1) Items indicated in "floor plans" above.
         2) Architectural features.
         3) Rack cabinets.
            a) Ventilation details.
            b) Power distribution detail.
         4) System furniture.
         5) Clearances required by applicable Code.
      f. System Conduit Riser Drawing, Show:
         1) Terminal cabinets.
         2) Coordination with floor plans.
         3) Wire runs not shown on floor plans.
         4) Wire type.
         5) Wire fill.
      g. Mounting details:
         1) Stamped and signed by an Engineer licensed in the Project jurisdiction for work of this type, where required by code.

2) Show loads, type and strength of connections, sizes, dimensions, materials, etc.
3) Show calculations on drawings or in bound volume for review by Authorities having jurisdiction.
4) Provide details for:
a) Equipment rack anchorage.
b) Loudspeaker mounts.
c) Video projector mounts.
d) Video display mounts
e) Projection screens, both fixed and motorized.
f) Attachment to building structure.

h. Installation details as required:
1) Terminal cabinets: Terminations.
2) Audio-Visual panel details.

i. Wire run sheets. Show:
1) Wire number.
2) Source.
3) Designation.
4) Signal type.
5) Wire type.
6) Operating level or voltage.
7) Timing reference, where applicable.
8) Physical length.

2. Shop (Fabrication) Drawings: Collate in sequence:
a. Contractor is to submit shop drawings in .DWF format.
b. Drawing index/symbol sheet (if separate set from Field Drawings).
c. System functional drawings. Submit separate drawings for each system/subsystem. Show at least:
1) Equipment:
a) Function, make, model.
b) Rack number, module frame and slot number.
2) Field device information
a) Terminal cabinets.
b) Pull boxes.
c) Audio-visual panel connector designations.
3) Wiring
a) Wire number.
b) Wire type.
4) Shield condition at both ends (float, ground, location of ground).
5) Connector wiring details, each type.
6) Audio: Nominal operating level, Polarity. Note deliberate polarity inversions where required to maintain absolute polarity.
7) Video: Physical length. Electrical length in nanoseconds or degrees of sub-carrier, as applies. Equalization required.
8) Twisted pair, transmit and received devices: Transmission range at 60 Hz., cable length and signal quality.

d. Provide drawings for the following systems, if applicable:
1) Audio.
2) Video.
3) Control.
4) Data transmission.

5) Coordinated grounding scheme.

e. Equipment rack elevations: Show:
   1) All racks scaled at 1 1/2" equals 1 foot, or larger.
   2) Rack: Make, model.
   3) Equipment: Function, make, model.

f. Rack wiring drawings: For each rack, show:
   1) Power strip: Receptacles, circuiting.
   2) Sequencing power and surge suppression systems.
   3) Equipment.
   4) Grounding.
   5) Wiring, all systems.
   6) Wiring harness scheme.
   7) Ventilation detail.

g. Fabrication details: Submit for:
   1) Receptacles.
   2) Panels.
   3) Special mounting provisions.

h. Legends/engraving details. Half or full size:
   1) Receptacles.
   2) Audio-visual panels.
   3) Equipment designations.

i. Patchbay elevations: Show:
   1) Patchbay elevations to be half-size scale.
   2) Equipment: Function, make, model.
   3) Patchbay type.
   4) Patchbay number.
   5) Connector configuration.
   6) Connector type.

E. Samples
   1. Of all finishes/materials that will be visible to the public, including but not limited to:
      a. Receptacles and controls with associated trim plate.
      b. Each type of loudspeaker baffle and/or grille.
      c. All audio-visual panels.
      d. Audio-visual devices in public areas.

F. Programming
   1. Control Programming Scheme Submittal
      a. Contractor is to provide submittal in electronic format (i.e. PDF)
      b. Provide a password-protected link to a folder on the Contractor's network to remotely access the touch panel from the Consultant's computer. Contractor is to have a dedicated control processor utilized on their network or provide an emulation file of each control system interface that will allow reviewer to operate the interface as if operating the actual device.
      c. Provide a graphic layout of each user control interface (touch panels, push buttons, etc.).
      d. Provide a list of devices that are controlled by each control user interface, including:
         1) Device.
         2) Brand.
         3) Model Number.

4) Control Method.
e. Provide a logic tree for each page for each control interface.
f. Provide a system routing sheet for each control user interface, including:
1) Source.
2) Switcher / device input.
3) Switcher / device output.
4) Final destination.
g. Provide help file content on each user interface.

G. Shop and Project Site Test Reports
1. Contractor is to provide submittal in electronic format (i.e. PDF)
2. Schedule: Submit test reports in a timely manner relative to the Project schedule such that the representative of the Owner may conduct Verification of Submitted Test Data without delay of progress.
a. Shop test report: Submit prior to shipping completed equipment racks to Project Site.
b. Project Site test report: Submit project site test report for this section after system completion and prior to Acceptance Review and Testing.
3. Content: Include at least:
a. Time and date of start of burn-in.
b. Time and date of test.
c. Personnel conducting test.
d. Test equipment, including serial and date of calibration.
e. Procedures used.
f. Results of test - numerical or graphical presentation.

H. Close Out Submittal
1. Contractor is to provide submittals in electronic format (i.e. PDF)
2. Operation and Maintenance Manuals
a. Index.
b. Systems operating instructions.
c. Reduced set of system Record Drawings.
d. Key schedule.
e. Maintenance and spare parts schedules.
f. Shop and Field Test Reports.
g. Equipment manuals. Collate alphabetically by manufacturer. Provide manufacturer's original operation, instruction and service manuals in color for each equipment item. Provide tabbed dividers between each product. Manuals provided by the Manufacturer in an individual binder may be submitted in that form.
3. Framed Operating and Maintenance Instructions: Provide adjacent to each ensemble of equipment racks. Provide sturdy frame with clear glass or non-scratching plastic cover. Provide permanent, non-fading media. Blueprints shall not be acceptable. Include:
a. Sequence for system start-up and shutdown.
b. System Functional Diagrams.
c. Signal levels and impedance at accessible system signal and test ports, where applicable.
4. Record Drawings
a. As work progresses, maintain records of "as installed" conditions. Update the set at least weekly. After successful completion of Project Site testing specified herein, and after completion of Punch List corrections, copy all

records of "as installed" conditions on to final Record Document drawings, as specified in Division 1.

b. Content: All drawings required under "Field and Shop Drawings". Show "as installed" condition. Where room designations according to Project permanent signage differ from construction designations in the Contract Documents, show both designations.

5. Provide four copies on SD card containing the “as built” drawings, all manuals, training manual and programming code.
   a. Submit un-compiled programming code.
6. Training Submittal
   a. Provide all training materials for review prior to scheduling training sessions.
      1) Training manual.
      2) Agenda for the training session.
      3) The final punch list, indicating that all equipment is fully functional.
   b. See the section under Owner’s Instructions for training manual requirements.
   c. No training session will be scheduled until final punch list is completed and submitted.
7. Warranty Certificates
   a. Comply with Division 1.

1.06 QUALITY ASSURANCE

A. Qualifications
   1. The bidder shall, prior to the bid, in accordance with the Instruction to Bidders, submit at least the following information to verify that the bidder has the necessary experience and qualifications to perform the specified work:
      a. A detailed brochure describing the bidder’s capabilities in terms of facilities, personnel (include a personnel organization chart followed by resumes), experience, background, examples of similar installations (at least two projects within the past two years), distribution arrangements with manufacturers and financial capability, including certificates of insurance and satisfaction of the project bonding requirements.
      b. Contractor must, at the time of this bid submittal, have distribution or a dealership agreement with all manufactures whose products are specified in the bid documents. Contractor must also have completed manufactures training and certification before bids are submitted.
      c. AIA Document A305 “Contractor’s Qualification Statement”.
      d. Information identifying any and all local agents and/or subcontractors that will assist in the work and their role in the project.
      e. Identification of sources of labor for all fabrication and installation throughout the duration of the project.
      f. Evidence that he has acquired all necessary licenses, certificates, and approvals to perform the specified work within the state or jurisdiction the work is to be performed.
   2. Projects that include Digital Signal Processing (DSP) equipment will require the Contractor to submit evidence of qualification from the manufacturer of said equipment. This would include completion of manufacturer’s training courses, the name of the person or persons who completed said training and prior projects completed using DSP technology. If the Contractor is not approved for

the DSP programming, they may hire a qualified programmer approved by the consultant.

3. Projects that include networked audio or video systems will require the Contractor to submit the name of the person, in their employment, qualified to perform this work. This person shall have certification in computer network technology and hold one of the following certifications:
   a. CNP – Certified Network Professional Program.
   b. Computing Technology Industry Association - Network+ certification.
   c. MCSE – Microsoft Certified Systems Engineer.
   d. CNE – Certified Systems Engineer.
   e. CCNA – Cisco Certified Network Associate.
4. Projects that include software configurable, integrated central control systems must include a factory authorized programmer who is fully engaged in the work of system programming 8 hours a day 5 days a week. This person shall hold the highest level of certification from the manufacture of the equipment being programmed.
5. It the contractor does not employ a programmer that meets the above requirement, the Contractor is to enter an agreement utilizing the authorized independent programmer as a sub-contractor. Under this agreement, the Contractor will retain all the responsibility for a complete and working system. The Contractor must include in their bid time to work out any programming bugs that may occur in the initial programming stage. These items include working through the initial and final programming stage with the authorized independent programmer to provide a functional system, testing the programmer's graphical user interface for intended functionality and provide onsite support for the programmer in the uploading and testing of programming revisions.
6. The control systems programmer shall be present either by web meeting or in person at the end user interviews to acquire information firsthand. The control systems programmer shall submit a report outlining the meeting results to Contractor for approval. Only when the Contractor approves this report shall it be submitted to the consultant for review.
7. The Contractor shall provide information on how and by whom the requirements of the warranty period will be fulfilled.
8. The submittal must justify, in the judgment of the Consultant, the Architect, and the Owner, that the Contractor has the capability to manage and install a project of this size and scope and that he is capable of the necessary business and technical arrangements for this installation and the pursuant warranty service. Contractor may be disqualified as a bidder if all of the submittal does not meet the approval of the Owner and his/her representative.
9. Company: Work of this Section shall be performed by a Sound or Audio-Visual Systems Contractor who has at least five years direct experience with the devices, equipment and systems of the type and scope specified herein, and who has a fully staffed and equipped maintenance and repair facility, and who is licensed to perform work of this type in the Project jurisdiction.
10. Personnel: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section. Supervisors shall have at least five years direct experience in similar work. Installation and maintenance personnel shall have at least three years direct experience in similar work.

11. Designated Supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual throughout the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.
12. Staff Engineer: The Contractor shall have on his full-time payroll at least one staff engineer having five years minimum experience as an electronics engineer covering systems and projects comparable in substance and complexity to the project described herein. The staff engineer shall have NICET certification in Electrical/Electronics Engineering Technology and Audio Systems or equivalent. The signature of that engineer shall appear on all shop drawings and submittals.
13. Coordination: Coordinate the Work of this Section with the Work of all other Separate Contracts. Comply with Division 1.
14. Help Desk: The Contractor must employ a fully staffed help desk department that shall provide knowledgeable responses to inquiries regarding system operation. This department must have the ability to provide remote diagnostics to identify equipment faults for troubleshooting.

B. Cutting and Patching
1. Cut, patch, and extend existing work using skilled mechanics that are capable of matching existing quality of workmanship.
2. Assign work of moving, removal, cutting and patching, to trades qualified to perform the work in a manner to cause least damage to each type of work, and provide means of returning surfaces to appearance of new work.
3. Perform cutting and removal work to remove minimum necessary, and in a manner to avoid damage to adjacent work. Cut finish surfaces such as masonry, tile, plaster, or metals, by methods to terminate surfaces in a straight line at a natural point of division.
4. When new work abuts or finishes flush with existing work, make a smooth and workmanlike transition. Patched work shall match existing adjacent work in texture and appearance so that the patch or transition is invisible.
5. Protect existing finishes, equipment, and adjacent work that are scheduled to remain, from damage.
6. Promptly repair damages caused to adjacent facilities by demolition operations, at no change in Contract Amount.

C. Painting
1. Use skilled mechanics that are capable of painting audio-visual equipment and hardware to match architectural surroundings, where applicable.

D. Regulatory Requirements
1. Regulations Applicable: including but not limited to those defined in Division 1.
2. Comply with all applicable federal, state, and local labor regulations, and applicable local union and trade regulations.
3. Installation practices shall be in accordance to industry-accepted standards (ANSI, Cal-OSHA, IEC, IEEE, FCC, NEC, NFPA, ICIA, NSCA, CEDIA, BICSI) or local acts, codes and standards enforced at the place of work, whichever is most stringent.
4. Procure and pay for all necessary permits, licenses, inspections, and observe any requirements stipulated therein.

5. Provide UL/ULC fire rated enclosures around all audio-visual floor and back boxes where required by code.

E. Programming
1. User Group Interview:
a. Conduct interviews with the end-users to acquire programming requirements. Submit written results of the interview and the requirements set forth by the user group. Associate the user group requirements into the programming of each sub system. Submit to the Consultant a report that outlines the interviews conducted.

F. Pre-installation Meetings
1. Attend a pre-installation meeting at the project site with the Owner and his representatives in order to coordinate related work and scheduling issues.

G. Verification
1. Verify dimensions and conditions at the Project Site. Submit any conflicts in timely manner for resolution.

H. Shop Fabrication and Testing
1. Assemble and fully wire equipment racks at a fabrication shop off the Project Site. Burn-in for not less than 120 hours. Following burn-in, perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Submit verification of shop test in timely manner. Following verification of shop test and when installation locations are ready as specified herein, deliver equipment racks and equipment to the Project Site and install.

I. Project Site Installation and Testing
1. Install as specified herein.
a. Perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Request verification of Project Site test in timely manner.

J. Verification of Submitted Test Data
1. Re-test in presence of designated representative(s) of the Owner at reasonable mutual convenience. Provide services of the designated supervisor and an additional technician familiar with work of this Section. Provide all test equipment. Provide complete set of latest stamped submittals of record for reference. Provide complete set of Shop and Project Site Test Reports, as applies. Provide a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.

K. Reference/Project Record Documents
1. At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete set of the latest stamped, action submittals of record for reference. Also maintain a separate, clean, undamaged set for preparation of Project Record Documents. Also maintain at the workplace a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading
1. The Contractor shall take receipt of all Owner Furnished Equipment at the project site or at a local warehouse.
2. Deliver materials in manufacturer's original undamaged packages or in bulk packing which provides equivalent protection from rough handling, dust and dirt.
3. Deliver all assembled equipment racks in custom manufactured wood crates to avoid damage during shipping.
4. All packing, shipping, insurance, handling and storage costs of equipment and materials shall be the responsibility of the Contractor.
5. The Contractor shall be responsible for insuring all equipment and installation materials stored in their shop facilities until it is delivered to the Project Site and a delivery acknowledgement is received from the Owner or its authorized representative.
6. Equipment unpacked for inspection but not ready for permanent installation must be returned into its protective packing.
7. The Contractor shall be responsible for furnishing a temporary substitute for equipment that could not be delivered in time for system operation. All costs associated for renting, shipping, and handling temporary substitute equipment shall be the responsibility of the Contractor.
8. In the event the equipment or installation material delivery is delayed, the Contractor must employ the fastest means of delivery service available to deliver the equipment on time. All costs for expediting the delivery of equipment shall be the responsibility of the Contractor.
9. Store packaged materials off the ground or slab in a manner to protect them from elements, especially moisture damage.
10. Deliver completed, wired, tested equipment racks to associated equipment rooms at the Project Site when major work of all other separate contracts is complete, equipment room ventilation is operating with clean filters in place, the area is clean and free from airborne contaminates, and continuing work of other trades will not produce airborne contaminates or permit transport of such airborne contaminates to the equipment rooms.

B. Acceptance at Site
1. All equipment and installation material delivered to the Owner shall be properly documented in the form of delivery receipts.
2. Equipment delivered to the Project Site must include a delivery acknowledgement receipt signed by the Owner or its representative. Issue a signed copy of the delivery receipt to the Owner and file the signed copy for future reference.
3. The Contractor shall be responsible for the insurance coverage and security of equipment delivered to the Project Site until it receives an acknowledgement of delivery from the Owner or its authorized representative.

C. Storage and Protection
1. The Contractor shall provide a safe and secure storage location for all equipment and installation materials until they are delivered to the Project Site and it receives an acknowledgement of delivery from the Owner or its authorized representative.

2. For equipment assembled and tested at the Contractor's shop facility and delivered to the Project Site, ensure that the equipment is properly protected from improper handling, rain, water, humidity, moisture, heat, direct exposure to sunlight, dust and dirt during delivery and storage on or off the Project Site.
3. Do not remove protective packing from equipment until they are ready to be installed.
4. If, after equipment is installed, the Project Site cannot be cleaned or is still not clean because of on-going work by others, provide protective covering and protection to prevent airborne dust and dirt originating from damaging equipment.

1.08 PROJECT SITE CONDITIONS

A. Environment Requirements
1. The spaces where audio-visual system assemblies are installed shall meet the following requirements:
a. Free from dust generated from construction.
b. The room temperature shall be within the specified operating temperature recommended by the manufacturer.

1.09 SEQUENCING

A. Submit all testing documentation to the Owner's Representative for review prior to requesting the Fabrication Inspection and Substantial Completion inspections.

B. Allow adequate time for corrections to be made after inspections to maintain the Project Schedule.

1.10 SCHEDULING

A. Comply with the Project schedule.

B. Make all Submittals specified herein in a timely manner. Failure to make timely submittals complete as specified herein is considered to be lack of substantial progress of the Work of this Section. Contractor is to work around client schedule throughout the duration of the project.

C. Deliver all equipment, devices and materials required for the Work of this Section and install, test and ready all work for Acceptance Testing at least fourteen days prior to the completion date for the associated area of the Project, unless specifically instructed otherwise by the Owner.

D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Owner, in lieu of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven days prior to the completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.

E. It shall be a common understanding that there is a time constraint when executing this work. The Contractor shall use all means and resources to complete this project on or before the specified schedule at no additional cost to the Owner. This includes

working beyond normal business hours and days, additional manpower, additional tools, etc.

1.11 WARRANTY SERVICE

A. Warrant all Work of this Section to be free from defects in materials and workmanship for a minimum of 1 year from the date of Owner acceptance of the Work of this Section.

B. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty may be voided. In such cases, provide a warranty equivalent to that of the original manufacturer.

C. All high-level software shall follow the warranty conditions specified by the manufacturer. Immediately update or upgrade the Owner's installed software as soon as new versions, updates or patches become available from the manufacturer at no additional cost to the Owner within this warranty period.

D. Response Time: Provide a qualified technician familiar with the work at the Project Site within 12 hours after receipt of a notice of malfunction. Provide the Owner with the telephone number attended 8 hours a day, 5 days a week, and an answering service or equivalent facility attended 24 hours a day, 7 days a week, to be called in the event of a malfunction. Provide repairs at no expense to the Owner and at the Owner's request, alternate facilities, services, and systems for the duration of the repairs to any defective work of this Section. Provide a complete and operational System, within 48 hours after notification of a malfunction.

E. All work requested due to warranty issues shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or nighttime work.

F. The Contractor shall use qualified service personnel to respond to all warranty issues or calls.

G. Off Site Service: Conduct all warranty repairs and services at the Project Site, unless in violation of manufacturer's standard product warranty. Provide substitute systems, equipment, and/or devices acceptable to the Owner for the duration of off-site repairs. Provide transportation for substitute and/or test systems, equipment, devices, materials, parts, and personnel to and from the Project Site.

1.12 OWNER'S INSTRUCTIONS

A. General
   1. Conduct training on the completed system at a reasonable convenience of the Owner during normal Owner business hours. Contractor is to assess the complexity of the system and shall fully train the operation and maintenance staff named by the Owner.
   2. Do not start training until all systems have been commissioned, training manuals are approved and an agenda along with schedule of each departmental training session has been submitted to the owner.

3. Training shall be conducted in the actual room that is the topic of the training session.
4. The client asserts legal and beneficial ownership of all training materials which are specifically commissioned for this project.

B. Operator Training – Do not start training before system is in full operation and all components have been signed off by owner's representative. Use the items covered in the commissioning portion of this specification as a basis for the training curriculum.
   1. At least two 4-hour sessions of instruction will be given to familiarize the Owner and staff with the operation of the system.

C. Maintenance Training
   1. At least two 4-hour sessions of instruction will be given in order to learn how to maintain and troubleshoot the system. A maintenance binder shall be provided by the Contractor with all manufacturer-specific operating and maintenance information for each piece of equipment used. On large jobs, the binders will be sub-divided into individual audio, video and control binders. Provide training on at least the following system features:
      a. Firmware upgrades
      b. Helpdesk features
      c. Complete use of system as outlined in the Commissioning section plus advanced troubleshooting.

D. Training Video
   1. A training video shall be produced and cover all aspects of the systems operation.
   2. Each page of all user interfaces shall be explained and recorded while gestures are made on the screen. Each button on the user interface shall be explained and demonstrated.
   3. All portable equipment that connects to the system shall be demonstrated both in their physical connection and routing method at the user interface.
   4. All patch bays shall be explained and demonstrated.
   5. All source equipment shall be explained in both physical loading of media and transport control as well as user interface control.
   6. Demonstrate on basic troubleshooting.
   7. Provide training on items as outlined in the Commissioning section of this document.
   8. Demonstrate system start up and shut down.
   9. Explain and demonstrate help files associated with touch panels.
   10. Audio and video files shall be combined and burned to DVD for distribution to each department.
   11. Provide professional MP4 with searchable index of topics covered.
   12. Provide label with client's logo, room name/number, title, length and topics covered.

E. A training manual specific to this system will be written covering the basic and advanced functional techniques necessary to operate the system in a reliable and fully functional condition. The Contractor shall submit hard color copies of the training manual as well as a soft copy in PDF or DOC format. Provide a hard copy of the training manual for each person to be trained. This manual shall include:
   1. All contact information, including emergency and after-hours phone and pager numbers, for requesting service assistance from the Contractor.

2. A 11x17 set of as-built drawings of the completed project (a full-sized set will be issued to the client for their use, a half-size set will be attached to the inside back door of the main equipment rack).
3. A table of contents at the beginning of the manual.
   a. The manual will begin by explaining basic information such as manual references, abbreviations, any assumptions made by the author, prerequisites required, numbering convection, etc.
   b. It will then proceed to the manual objectives.
   c. Explain what the end user should understand after reading the manual.
   d. It will cover the basics of the user interface including start up and shut down procedures, log on procedures, access privileges, operator password, levels of security, file structure, etc.
   e. The manual shall proceed to describe each user interface and its function. It will cover every layer of the interface and how to navigate through them.
   f. Each of the system presets shall be explained and the physical setup of the equipment and floor plan during presets shall be illustrated. Source equipment shall have their routing scheme explained and illustrated. Portable equipment and its connection to the system shall be explained and illustrated.
   g. The manual will end by explaining basic troubleshooting procedures and equipment care instruction.
4. The Contractor's maintenance instructions, which will include the manufacturer's maintenance instructions found on the factory manuals to keep the manufacturer's warranty in force.
5. A list of consumables (fuses, batteries, etc.) required to keep the system operating over time, along with sources of supply (if not readily available).
6. The Contractor shall compile and submit all factory warranty registration forms or cards for each piece of equipment furnished for this project.
7. A form requesting feedback from the end user as to how the manual can be improved and a section to report errors discovered.
   a. The Contractor shall make the corrections and improvement suggestions after receiving feedback from the users. This will be completed at no charge to the client. The manual will contain a date stamp and version number. Each feedback and error correction manual reissue will include a new version number.

F. Initial Use Support
   1. Provide standby trainer/system engineer during the first two public events.

1.13 MAINTENANCE

A. The Contractor shall, within the warranty period, schedule two visits to inspect and perform preventive maintenance on the system. The first visit shall be six months after the commencement of the warranty period. The last visit shall be just prior to the end of the warranty period.

B. Cache for event logging must be set to record unlimited events until the Contractor's first maintenance site visit. After the Contractor's first maintenance site visit, the cache can be limited to the Owner specified level.

C. The Contractor shall use qualified service personnel to conduct all maintenance work.

D. All maintenance work shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or night time work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Quality of Products
1. Materials and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the specified systems.
2. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail.
3. Each material, device or piece of equipment provided herein shall comply with all of the manufacturer's published specifications for that item.
4. Equipment shall be from the manufacturers' current stock and shall not be stored longer than 1 year prior to installation, unless written approval to do otherwise is provided by the manufacturer and submitted for review by the Owner.
5. All products shall be a product of firms regularly engaged in the manufacturing of electrical, electronic or optical equipment. The equipment shall be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions are prohibited and should not be submitted for review.
6. Quality of workmanship and fabrication of all equipment and components, which are custom fabricated, shall be comparable to professional equipment produced by specialized manufacturers of the trade involved and will be verified by inspection. Only firms having 5 years of experience in all aspects of the fabrication and installation of similar systems will be allowed to perform the work.
7. All materials and products shall be new and of professional quality. Unless specifically stated in the drawings or specifications, no existing or used materials will be installed.

B. Quantity
1. Provide the quantity of products as shown on the Contract Drawings, or as otherwise indicated herein.
2. The equipment listed in section 2.2 consists of all major equipment for the project. The Contractor shall integrate into the system design and provide any additional components, wiring, programming, etc., to complete a functional system operating as described within the specifications and the for construction drawings.
3. Components or equipment not specified or indicated on the drawings that are required to make a fully functional systems per the Owner's requirements and the design intent, shall be furnished and installed by the Contractor, and shall be submitted for Owner review.

C. Preference
   1. Where more than one manufacturer is listed herein as acceptable or equivalent, no preference is intended or implied by the order of listing.

D. In the event that a specified piece of equipment or product has been superseded, discontinued or is no longer available from the manufacturer, the Contractor shall submit a request for substitution of the originally specified product. The substitute product shall be the manufacturer's most current model of the specified product, or if the line has been discontinued, a product by the same manufacturer with specifications meeting or exceeding, and as close as possible to those of the originally specified product. Refer to Alternatives and Substitutes section for clarification.

E. Provide Complete
   1. Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.

F. Provide New
   1. All materials provided under the Work of this Section shall be new, shall be the manufacturer's latest design/model, and shall be permanently labeled with the manufacturer's name, model number and serial number.
   2. Products and materials shall be clean, free of defects, damage and corrosion.

G. Similar
   1. Similar devices shall be of the same manufacturer, unless specifically noted otherwise in these specifications.

H. Safety Agency Listing
   1. All devices provided under the Work of this Section that are connected to the Project electrical system shall be listed by Underwriters Laboratories (UL) or other Nationally Recognized Electrical Testing Laboratory acceptable to the Authorities having jurisdiction at the Project site and shall be so labeled. Absent such listing, comply with Regulatory Requirements applicable to Unlisted Equipment.

I. Power Rating
   1. All devices provided under the Work of this Section that are connected to the Project electrical system shall provide stable performance in full accordance with these specifications when operated on main service which complies with ANSI standard tolerances for voltage, frequency, transients, and related parameters.

J. Circuit Protection
   1. All active devices shall include integral fuse or circuit breaker protection.
   2. All circuit breakers shall be fully magnetic.
   3. Protection devices shall be located to facilitate examination, resetting and/or replacement without the need to disassemble or demount the associated device.
   4. Contractor-fabricated items shall be provided with either indicating type circuit breakers or fuses of the clear glass cartridge type, mounted in fuse holders which will indicate a blown or defective fuse.

K. Continuous Use
1. All active circuitry shall be solid state and shall be rated for continuous use. All circuit components shall be operated in full compliance with the manufacturer's recommendations and shall contain sufficient permanent identification to facilitate replacement.

L. Construction
1. All electronic equipment shall be of the "dead-front" type and shall be designed for standard 19" EIA rack mounting, unless otherwise indicated.
2. Steel frames and enclosures shall be designed and wired to eliminate all induced currents within both the units and the systems.
3. All bolted connections shall be made with self-locking devices.
4. Coordinate all consoles and panels so that the general appearance is similar, or as directed by the Owner.
5. All operating panels shall be at least 1/8" thick aluminum.
6. Provide locking panel covers on all recessed, semi-recessed or surface mounted control panels not located in the equipment rooms, unless specifically noted otherwise. Panel locks shall be flush with no protrusions beyond the panel face when the door is closed. Recessed control panels shall be recessed within the back box to a depth sufficient to permit a locking hinged panel cover to completely close without affecting any device within the enclosed area.

M. Circuit Boards/Modules
1. All printed circuit boards or modules shall be mechanically secured by bolt or friction-loading guide, in addition to any electrical connector attachment, and shall include an integral extraction grip.
2. Printed circuit boards shall be connected to associated circuitry via soldered connections or precious metal positively keyed card edge connectors.
3. All Contractor-fabricated printed circuit boards shall be at least 1/16" thick G-10 glass fabric epoxy base, copper plated to a minimum density of 2.0 oz./sq. ft. on one or both sides and finished with 60/40 tin/lead solder either hot rolled or plated over the copper. All holes through the boards shall be plated through and solder filled. All boards shall be permanently identified with a designation that matches that of the mating connector or board position in the assembly.

N. Identification
1. Provide permanent intelligible identification on, or adjacent to, all connectors, receptacles, controls, fuses, circuit breakers, patching jacks, and the like. This identification shall clearly and distinctly indicate the function of the item and shall be numbered or lettered to correspond with the function, circuit and location consistent with field and shop drawings.

O. Modular Products
1. The drawings show conventionally packaged components to convey design intent.
2. Card cages to have front and rear closure panels to provide a finished appearance.
3. Except as noted below, modules of different functional types are permitted to share the same card cage/mounting frame and/or power supplies as applicable and if mechanically and electrically compatible.
4. With amplifier input driven 10 dB beyond input level required to produce full rated output, amplifier shall withstand indefinitely any of the following load

conditions without instability of operation of main over current protection (i.e. no blown fuses or circuit breakers).
a. "Short" circuit of 0.1 ohm.
b. Open circuit (no load).
c. Rated load impedance.

5. Maintain sense of signal polarity from input to output.

P. Keys
1. Key all boxes, cabinets, enclosures, panels, controls, doors and related provided for similar usage within a system identically. For each unique key type, provide a quantity of ten. Stamp each key with a reference designation.
2. Submit a schedule of keying to the Owner. Where so noted, provide Project Standard lock cylinders and keys; coordinate with the work of other Sections.

Q. Lectern Power Cord
1. The power outlet connecting the lectern to the floor box must be twist-lock type. The power cord connecting the podium to the floor box must be 12 inches shorter that the low voltage cable connecting it. This will protect the low voltage cable from damage if the podium was to be moved inadvertently without disconnecting the cables. The power cable shall include a wire-rope strain relief to keep the power cord from damage. See cable detail on plan-set for more information.

R. Assistive Listening System (IR)
1. An assistive listening system using Infrared type headsets will provide personal monitoring of the audio program for the hearing impaired. A frequency agile transmitter with no less than 2 channel capability will broadcast the main audio program to personnel headsets. The system and quantity of headsets supplied shall conform to the ADA requirements (section 219 and 706) for the space. Stereo headset type and hearing aid compatible (T-Coil) listening devices will be provided; ear bud type devices are not acceptable. A drop-in type battery charging system capable of servicing multiple receivers simultaneously will be supplied with this system. Provide enough battery charging capacity to charge each receiver supplied simultaneously. Follow the table below for quantity requirements.

Capacity of Seating in Assembly Area	Minimum Number of Required Receivers	Minimum Number of Required Hearing Aid Compatible Receivers
50 or Less	2	2
51 to 200	2, plus 1 per 25 seats over 50 Seats *1	2
201 to 500	2, plus 1 per 25 seats over 50 Seats *1	1 per 4 Receivers *1
501 to 1000	20, plus 1 per 33 seats over 500 *1	1 per 4 Receivers *1
1001 to 2000	35, plus 1 per 50 seats over 1000 seats *1	1 per 4 Receivers *1

2001 and over	55, plus 1 per 100 seats over 2000 seats *1	1 per 4 Receivers *1

*1 Or fraction thereof

S. Projection Screens
   1. Provide extra screen material drop to locate the projection screen at the optimum viewing angle where required. Verify screen drop requirements with architectural sections and elevations.

T. Provide enclosure systems including, but not limited to racks, cabinets, cases and related panels and accessories as specified herein, or approved equivalent. Provide size and quantity as shown on drawings. Provide color as specified by Architect. If no color is shown on drawings, submit manufacturer's standard color chips for selection.

U. Cable Tray: Provide aluminum ladder style cable tray with flange in side rails where called out in drawings. Size the cable tray to accommodate all wire that must pass through it. Provide all supporting hardware and accessories.
   1. Ladder Style Cable Tray
      a. P-W Industries.
      b. Equal by Hubbell.
      c. Approved equal.

V. Floor Mounted Equipment Racks: Provide each bay with basic frame, vented locking rear door, top panel with single 10” fan, certified seismic floor anchor kit, ganging hardware, except where otherwise indicated, at each ensemble of bays, provide end (side) panels to provide complete enclosure.
   1. Rack cabinet, heavy duty welded 14ga. CRS, single bay of maximum dimensions 83-1/8"(H) x 24"(W) x 32.5"(D); floor supported with accessory louvered side rack side panel.
      a. Mid Atlantic WRK Series.
      b. Equal by Atlas/Soundolier.
      c. Approved equal.
   2. Turret cabinet:
      a. Mid Atlantic Slim 2 Series.
      b. Equal by Atlas/Soundolier.
      c. Equal by Hammond Manufacturing.
   3. Wall cabinet, tilt out:
      a. Atlas/Soundolier AWR Series.
      b. Mid Atlantic WRS Series.
      c. Equal by House of Metal Enclosures (HOME).
      d. Equal by Hammond Manufacturing.
   4. Wall Mounted cabinet:
      a. Atlas/Soundolier 300 Series.
      b. Mid Atlantic DWR Series.
      c. Equal by Hammond Manufacturing.
   5. Floor mounted pivoting rack:
      a. Mid Atlantic SR-40-22 Swing Rack.
      b. Equal by Atlas/Soundolier.

W. Rack Panels and Accessories: Rack Mounting Screws: Screws 10-32; length as required for at least 1/4" excess when fully seated; oval head with black plastic non marring cup washer or equivalent ornamental head; nickel, cadmium or black plated; Phillips, Allen Hex, Square-Tip or Torx drive. Slotted screws are not acceptable.
   1. Blank Panels:
      a. Atlas/Soundolier S19 Series.
      b. Zero ZP112000 Series.
      c. House of Metal Enclosures (HOME) Series PM.
      d. Middle Atlantic Products BL, SB or HBL Series.
   2. Vent Panels:
      a. Middle Atlantic ETF Series.
      b. Equal by Atlas/Soundolier.
      c. Equal by Zero.
      d. Equal by House of Metal Enclosures (HOME).
   3. Shelf:
      a. Middle Atlantic Products U Series.
      b. Atlas/Soundolier SH19 Series.
      c. Zero A52 Series.
   4. Drawer:
      a. Atlas/Soundolier SD Series.
      b. Middle Atlantic Products UD Series.
      c. House of Metal Enclosures (HOME) SD Series.
      d. Zero A43/A36 Series.
   5. Rackmount Computer Keyboard: Middle Atlantic RM-KB.
   6. Equipment Custom Rackmount Shelf: Middle Atlantic Products Model RSH-4A Series.
   7. Rackmount Computer Keyboard.
      a. Mid Atlantic RM-KB series.
      b. Approved equal.
   8. Computer Monitor Rackmount.
      a. Mid Atlantic RM-MM series.
      b. Approved equal.
   9. Horizontal Lacer Bars
      a. Mid Atlantic LBP-IR4, LBP-1S, LBP-1P.
      b. Equal by Atlas/Soundolier.

X. Equipment Enclosure Ventilation: Provide UL Recognized devices. Connect to enclosure power, comply with applicable Codes.
   1. Fan panel, 5 1/4" high painted steel rack panel with 4" diameter fans, each fan with chrome plated finger guard, low speed air flow, two fans per panel, total 120 CFM:
      a. Mid Atlantic QFP-2 Series.
      b. Atlas/Soundolier ES/IS Series.
      c. BGW Systems.
   2. Thermostatic Fan control module, user definable temperature range with status LED’s, temperature sensing probe.
      a. Middle Atlantic FC Series.
      b. Atlas/Soundolier CFT Series.

Y. Equipment Enclosure Power and Signal Grounding: Comply with applicable Codes and applicable portions of Division 26. Provide UL Listed devices, Specification or Hospital Grade. Provide all junction boxes, raceway, fittings, wire, supports and

fastenings as required for complete installation. Unless otherwise noted, provide receptacles of NEMA 5-15R configuration.

1. Full height receptacle strip, Isolated Ground:
   a. Wiremold 3000 Plugmold IG Series.
   b. Middle Atlantic PD series vertical power strips.
2. Full height receptacle strip, three or more circuits, Isolated Ground:
   a. Wiremold 3000 Series with Specification Grade IG 5262 Series receptacles.
   b. Middle Atlantic PD series vertical power strip.
3. Wireway, lay in, NEMA 1: Any meeting NEMA 1 and UL870. Size as required.
4. Flexible metal conduit: Comply with Division 26.
5. Sequencing Power System:
   a. The Contractor is to design and build power sequencing and surge suppression systems that will control and distribute power in the equipment racks. The system will be designed to sequentially connect power to all of the audio-visual equipment in the equipment racks. Outlets are mounted to the unit's back plate or on a remote strip. If the project utilizes a control system, the sequencing power system will be controlled by the software configurable control system. The touch panel's shut down button will prompt a second time asking, "Are you sure you want to shut the system down?" A positive response will activate system shut down. A push button control station's shut down button will be pressed twice to shut down the system. If the project does not include a control system, the Contractor is to provide a dedicated sequential controller in the equipment racks.
      1) 15 amp or greater power capacity.
      2) 3-prong 15 amp 120VAC isolated ground outlets (provide required amount).
      3) Individual sequencing steps for each outlet.
      4) Adjustable power-up time delay and outlet sequencing intervals.
      5) Modular power raceway systems shall be constructed of 18-gauge min-spangle galvanized steel.
      6) Remote controllable via contact closures (if applicable).
      7) Status indicator on touch panel (if applicable).
   b. Approved subject to above:
      1) Middle Atlantic RLM-XX, RM-XX, R-XX or M-XX Modular Power Raceway Series.
      2) Middle Atlantic USC-6R Universal Sequencing Controller.
      3) Equal by Atlas Soundolier.
6. Signal Grounding bus bar, insulated from enclosure frame:
   a. Atlas/Soundolier BBG Series mounted on standoff insulators.
   b. Zero A32 Series.
   c. Middle Atlantic.
   d. Panelboard Isolated Ground bus kit by manufacturer of Project Panelboards specified in Division 26.
7. Multi-Outlet Assembly, Surge Suppressing, UL Listed. Comply with ANSI/IEEE C62.41-1980. Provide at least six receptacles. Provide equivalent to:
   a. Surgex SX RT series.
   b. EFI Electronics Corporation Model 153.
   c. MCG Electronics, Inc. Model 296 (subject to UL Listing).
8. Computer Grade Uninterruptible Power System, UL Listed. Provide continuous, no-break power with sine wave output. Provide Transient Over-

Voltage (TOV) Surge Suppression; comply with ANSI/IEEE C62.41-1980, Category A and Category B. Provide complete isolation from Line. Provide output voltage regulation to ANSI C84.1 for computing equipment. Provide output KVA, switch-mode power supply rated, not less than 150% of connected load indicated. Provide one for each Central Processing Unit, Digital Signal Processor, and automated control console. Provide equivalent to:

a. Best Power Technology, Inc. "Micro-Ferrups" Series.
b. Best Power Technology, Inc. "Axxium" Series.

Z. Audio Patching and Related:

1. Audio Patching Jack Assemblies; jackfield two times forty-eight (2x48) jacks: Factory pre-wired to insulation displacement connection system, normals brought out to connection system, connection system on backplane of jackfield chassis or a separate unit on cable harness, 2 row by two times forty-eight (2x48) jack array of Bantam Plugs:
   a. ADC Pro Patch Mark IV (Bantam).
   b. Bittree Audio TT (Bantam).
   c. Switchcraft TTP96FA (Bantam).
2. Audio Patching Jack Assemblies; jackfield 48 jacks: Factory pre-wired to insulation displacement connection system, normals brought out to connection system, connection system on backplane of jackfield chassis or a separate unit on cable harness, 2 row by 24 jack array of 1/4" tip-ring-sleeve Longframe pattern jacks:
   a. ADC Pro Patch Mark IV Long Frame.
   b. Bittree Audio Long Frame ¼”.
3. Audio Patching Cords: Manufactured to match mechanically, electrically and materials with audio patching jack assemblies specified herein. Flexible shielded cable, length as required. Provide with non-corroding metal. Provide equivalent to:
   a. ADC Pro Patch ¼” Long Frame Patch Cords.
   b. ADC Pro Patch Bantam.
   c. Bittree ¼” Long Frame Patch Cords.
   d. Bittree Audio TT (Bantam) Patch Cords.
   e. Provide Quantity:
      1) Two foot: Eight for each 2x24 Audio Jackfield.
      2) Two foot: Sixteen for each 2x48 Audio Jackfield.
4. Audio Patching Cords, Adapter: Manufactured to match mechanically, electrically and materials with audio patching jack assemblies specified herein. Flexible shielded cable, length six feet. Provide with non-corroding metal 1/4" tip-ring-sleeve longframe pattern plug one end equivalent to Neutrik. Provide opposite end, Circular Audio Connector, Cord, as specified herein. Provide equivalent to:
   a. Patch to Male:
      1) Audio-Line 310 Series.
      2) Pro Co Sound C-PJ/MXB-B-6-P2H.
   b. Patch to Female:
      1) Audio-Line 310 Series.
      2) Pro Co Sound C-PJ/FXB-B-6-P2H.
   c. Provide Quantity:
      1) Patch to Male: Provide 12.
      2) Patch to Female: Provide 12.

5. Patching Cord Holders: Provide adjacent to each jackfield. Provide quantity as required to store patching cords specified herein:
   a. Audio Accessories Maxi Holder.
   b. Trompeter Electronics Model CH-50.
   c. Pomona Electronics 4408.

AA. Video Patching and Related:
1. Video Patching Jack Assemblies; jackfield (2x32) isolated jacks: 75 Ohm digital and analog capable, ((2x32) jack array, 3GHz bandwidth, SMPTE 259M and 292M compliant:
   a. Canare (MD-Series)
   b. Bittree (Mini-WECO)
   c. ADC (PV-Series)
2. Video Patching Cords: Manufactured to match mechanically and electrically with video patching jack assemblies specified herein. Flexible shielded cable, length as required. Provide with non-corroding metal. Provide equivalent to:
   a. Canare (Mid-size Video Patch Cord)
   b. Bittree (Mini-WECO Patch Cord)
   c. ADC (ST series Patch Cord)
   d. Provide Quantity:
      1) Two foot: twelve for each 2x32 Video Jackfield.

BB. Data Patching and Related:
1. Data Patching Jack Assemblies; jackfield two times twenty four (2x24) jacks. Meet or exceed Category 6 requirements described in TIA/EIA-568-C.2-1 as well as the Class E requirements described in ISO/IEC 11801-B.:
   a. Leviton eXtreme 6+ Quickport Patch Panel (or equal).
2. Provide patch cords for patch points as required.

CC. Fiber Patching and Related:
1. Fiber Patching Jack Assemblies. Meet or exceed all TIA/EIA-568-C requirements:
   a. Leviton Opt-X Ultra Fiber Rack Mount Enclosure (or equal).
2. LC type adapters.
3. Provide patch cords for patch points as required.

DD. Basic Microphone Package
1. Provide basic microphone package to consist of:
   a. Two handheld vocal microphones equal to Shure SM58-LC
   b. One handheld vocal microphone equal to Shure Beta 58A.
   c. One instrument microphone equal to Shure SM57.
   d. One instrument microphone equal to Shure KSM137.
   e. One instrument microphone equal to Shure Beta 27.
   f. Supply 25 ft cable for each microphone equal to Shure C25B.
   g. Supply six microphone stands equal to Ultimate Support Pro-SB.

2.02 PRODUCTS

A. Major System Components

DEVICE ID	DESCRIPTION	MANUFACTURER	MODEL	ACCESSORIES

ADI	ANALOG TO DIGITAL INPUT	YAMAHA	EXI8	
AIU1	ANALOG INTERFACE UNIT	YAMAHA	Rio1608-D2	
AIU2	ANALOG INTERFACE UNIT	YAMAHA	Rio3224-D2	
ALR	ASSISTIVE LISTENING RECEIVER	LISTEN	LR-4200-IR	
ALT	ASSITIVE LISTENING TRANSMITTER	LISTEN	LT-82	
AMS1	AUDIO MONITOR SPEAKER	JBL	306P MkII	
AMS2	AUDIO MONITOR SPEAKER	FOSTEX	RM-3	
ANT	ANTENNA	SHURE	UA820	AS REQUIRED FREQUENCY
BC1	BATTERY CHARGE	LISTEN	LA-380	
BC2	BATTERY CHARGE	CLEAR-COM	AC40A	
BDP	BLU-RAY DISC PLAYER	TASCAM	BD-MP4K	
CAM	PAN-TILT CAMERA	LUMENS	VC-A71P	
CM1	HDBASE-T INPUT CARD MODULE	CRESTRON	DMC-4KZ-C	
CM2	HDBASE-T OUTPUT CARD MODULE	CRESTRON	DMC-4KZ-CO-HD	
CM3	HDBASE-T INPUT CARD MODULE	CRESTRON	DMC-4KZ-HD	
CMIC	CEILING MICROPHONE	SHURE	MX202	
CPU2	CENTRAL PROCESSING UNIT	DELL	OPTIPLEX 3010	3RD GEN INTEL CORE i5, QUAD CORE, 6MB, 3.20GHz, WINDOWS 7 PRO, 8GB DDR3 SDRAM, AMD RADEON HD7470 1GB,DVD +/- RW, 1TB HD, MS OFFICE, DSP AND CONTROL SOFTWARE

CPU3	CENTRAL PROCESSING UNIT	DELL	OPTIPLEX 3010	3RD GEN INTEL CORE i5, QUAD CORE, 6MB, 3.20GHz, WINDOWS 7 PRO, 8GB DDR3 SDRAM, AMD RADEON HD7470 1GB,DVD +/- RW, 1TB HD, AUDINATE DANTE PCIe-R SOUND CARD, Steinberg Nu-endo Live recording software
DA1	DISTRIBUTION AMPLIFIER	APHEX	120B	
DSP	DIGITAL SIGNAL PROCESSOR	YAMAHA	MTX5-D	AS REQUIRED I/O CARDS AND CONFIGURATION
ERK1.#	P/O EQUIPMENT RACK	MIDDLE ATLANTIC	SR-40-28	SEE SECTION BELOW FOR ACCESSORY REQUIREMENTS
ERK2	P/O EQUIPMENT RACK	MIDDLE ATLANTIC	DWR-35-26	SEE SECTION BELOW FOR ACCESSORY REQUIREMENTS
HP	HEADPHONES	LISTEN	LA-402	
IBP1	INTERCOM BELT PACK	CLEAR-COM	RS-701	
IBP2	INTERCOM BELT PACK	CLEAR-COM	RS-702	
IBS	INTERCOM BASE STATION	CLEAR-COM	BS210	
IC1	INTERCOM STATION	CLEAR-COM	WP-2	
IC2	INTERCOM STATION	CLEAR-COM	HB-702	
IC3	INTERCOM STATION	CLEAR-COM	KB-702	
IC4	INTERCOM STATION	CLEAR-COM	WP-6	
IC5	INTERCOM STATION	CLEAR-COM	KB-701	
IHS1	INTERCOM HEAD SET	CLEAR-COM	CC-300	
IHS2	INTERCOM HEAD SET	CLEAR-COM	CC-15	
IRT	IR TRANSMITTER	LISTEN	LA-140 IR	BKT 024
KB2	KEYBOARD	MICROSOFT COMPATIBLE		

LEC	LECTERN	MARSHALL	EXEC-32FD	LECTERN LIGHT, LOCKING CASTERS, COORDINATE FINISH WITH ARCHITECT
LI	LITGHTING INTERFACE		(APPROPRIATE MODULE)	
LP1	LECTERN PANEL	EXTRON	HSA 400	AS REQUIRED CONFIGURATION
M	MOUSE	MICROSOFT COMPATIBLE		
M1	MICROPHONE INPUT	FSR	T3-MJ	
MIC1	MICROPHONE	COUNTRYMAN	ISOMAX IV	
MIS	MAIN INTERCOM STATION	CLEAR-COM	MS-704	
MIX1	MIXER	YAMAHA	CL3	AS REQUIRED, I/O CARDS AND CONFIGURATION
MSC	MAIN SYSTEM CONTROLLER	CRESTRON	CP4	AS REQUIRED, I/O CARDS AND CONFIGURATION
NL	NECK LOOP	LISTEN	LA-438	
NWS1	NETWORK SWITCH	QSC (NETGEAR)	NS26-300+	AS REQUIRED FIBER TRANSCEIVER MODULES
NWS2	NETWORK SWITCH	QSC (NETGEAR)	NS10-125+	AS REQUIRED FIBER TRANSCEIVER MODULES
PA1500/4	POWER AMPLIFIER	QSC	CX-Q 4K4	
PA1700/2	POWER AMPLIFIER	QSC	CX-Q 4K4	
PA200/4V	POWER AMPLIFIER	QSC	MP-A40V	
PA500/4	POWER AMPLIFIER	QSC	CX-Q 2K4	
PA700/4	POWER AMPLIFIER	QSC	CX-Q 2K4	
PJS	PROJECTION SCREEN	DRAPER	PARAGON V - 11468 (16:10) 307" DIA.	TAB TENSION, MATT WHITE, LOW VOLTAGE CONTROL
PRK1	PORTABLE EQ RACK	SKB CASES	1SKB-R6UW	SEE SECTION BELOW FOR ACCESSORY REQUIREMENTS
PRK2	PORTABLE EQ RACK	SKB CASES	1SKB-R4UW	SEE SECTION BELOW FOR ACCESSORY REQUIREMENTS

PTC	PORTABLE CASE	PELICAN	1450	AS REQUIRED CONFIGURATION
RIS	REMOTE INTERCOM STATION	CLEAR-COM	RM-704	
RX1	RECEIVER	CRESTRON	DM-RMC-4KZ-SCALER-C	
RX2	RECEIVER	CRESTRON	DM-RMC-4KZ-100-C	
SB1	SUBWOOFER	QSC	WL212-SW	AS RQUIRED MOUNT AND MOUNTING HARDWARE
SC1	CEILING SPEAKER	QSC	AD-C6T	
SC2	CEILING SPEAKER	QSC	AD-C4T	
SFF	FRONT FILL SPEAKER	RENKUS-HEINZ	TRX61	
SP1	SPEAKER	QSC	WL3082	AS RQUIRED MOUNT AND MOUNTING HARDWARE
SP2	SPEAKER	QSC	K10	AS RQUIRED MOUNT AND MOUNTING HARDWARE
TPC1	TOUCH PANEL CONTROL	CRESTRON	TSW-1070	
TPC2	TOUCH PANEL CONTROL	CRESTRON	TS-1070-B-S	TSW-750-TTK-#-#
TPC3	TOUCH PANEL CONTROL	APPLE	iPad AIR	256 GB, WI-FI, CRESTRON CONTROL APP, YAMAHA CL STAGE MIX APP, SHUREPLUS CHANNELS APP.
TX1	TRANSMITTER	CRESTRON	DM-TX-4KZ-100-C-1G	
TX2	TRANSMITTER	CRESTRON	DM-TX-4KZ-302-C	
VD43	VIDEO DISPLAY	SAMSUNG	QB43R	CHIEF MSM1U MOUNT SERIES AND AS REQUIRED MOUNTING HARDWARE
VD50	VIDEO DISPLAY	SAMSUNG	QB50R	CHIEF LTM1U MOUNT SERIES AND AS REQUIRED MOUNTING HARDWARE
VM1	VIDEO MONITOR	NEC	EA224WMI-BK	AS REQUIRED MOUNT

VMS	VIDEO MATRIX SWITCHER	CRESTRON	DM-MD8X8-CPU3	AS REQUIRED, I/O CARDS AND CONFIGURATION
VPJ1	VIDEO PROJECTOR	BARCO	UDM-4K15	APPROPRIATE LENS, MOUNT AND AS REQUIRED MOUNTING HARDWARE
WAA	WIRELESS ANTENNA AMP	SHURE	UA830USTV	
WB	WIRELESS BELT-PACK	SHURE	ULXD1	
WBP	WIRELESS BELT PACK	CLEAR-COM	BP210	
WLM1	WIRLESS HEADSET MIC	COUNTRYMAN	E6 (TA4F)	
WLM2	WIRELESS MICROPHONE	SHURE	ULXD2/SM58	
WMR	WIRELESS MIC RECEIVER	SHURE	ULXD4Q	

B. The above list of Major System Components only outlines the major items necessary to allow the system to function as designed. It lists no power supplies, balancing transformers, power splitters, modular cards or other auxiliary components required to achieve a functioning system. Contractor is required to supply all components needed to provide a complete and operable system as outlined in the contract documents. The full set of construction documents are to be used when preparing a bid. This list is not intended to provide a full bill of materials.

C. Patch bays shown on plans and elevations are for placeholder information only. Contractor is to determine the exact amount of patch needed as per single line diagrams.

2.03 FINISHES

A. Any item or component of the Work of this Section which is visible shall comply with the following. Finishes noted or scheduled on the Contract Drawings shall take precedence. Submit all color samples of all items visible to public for approval.
   1. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the Owner.
   2. Paint loudspeaker cabinets to match exactly the surrounding and adjacent surfaces. Submit paint sample to Owner’s representative for approval.
   3. Unless otherwise noted, receptacle or device plates subject to connection or operating force shall be stainless steel or hard anodized aluminum. Provide plates which generally match the appearance of project standard receptacle or device plates in view in the same area. For anodized aluminum, submit samples of standard colors for selection by Owner.
   4. Operating panels shall be steel, primed, painted with thermosetting epoxy paint, with legends silk-screened in contrasting color, and coated with clear epoxy thermosetting coating; or aluminum, hard anodized, with legends engraved and filled with contrasting color, all coated with clear epoxy thermosetting coating.

5. All steel surfaces shall be treated with primer equivalent to zinc phosphate and finish painted with baked enamel or painted with a thermo setting epoxy paint.
6. All aluminum surfaces, except those used as operating surfaces, shall be anodized and then painted with a thermo setting epoxy paint.

B. Custom Fabricated Plate Screws
1. Match the finish of the screws used to mount the custom fabricated plates with the finish of the custom fabricated plate.

C. Ceiling Loudspeaker Grilles
1. Paint loudspeaker grilles to match exactly the surrounding and adjacent surfaces (when speakers are recessed). Apply paint to permit servicing of loudspeakers without damage to finish of adjacent or adjoining surfaces. Provide uniform appearance. Do not obstruct grille openings with paint. Submit paint sample to Owner's representative for approval.

D. Equipment or Cover Plates
1. Paint equipment or cover plate to match exactly the surrounding and adjacent surfaces when require by architect.

E. Manufacturer's logos
1. Remove all manufacturers' names, logos, or other symbols from speakers or other objects placed in view of the public.

2.04 ALTERNATES AND SUBSTITUTES

A. Substitutions of equal equipment beyond the alternatives listed will be permitted only in accordance with Division 1. If a requested substitution requires a change in any of the contract drawings, a revised drawing must be submitted as part of the substitution request. The Owner's Representative shall be the final judge of the acceptability of substitutions. The burden of proof of equivalence is the responsibility of the Contractor.

B. Acceptance of a product shall not, in any form or manner, relax the system performance requirements of this Specification and the performance characteristics of the product.

C. The Contractor shall submit for review a complete list of proposed substitutions for approved equipment listed in Part 2.

D. For all substitutions, the Contractor shall provide the manufacturer's independent test data to demonstrate that the proposed alternatives to the approved equipment comply with the specifications. Specifications shall contain at least all information available for the specified product.

E. The Contractor shall submit a description and drawings showing all changes to the Contract Documents that the proposed substitution will require for proper functionality and operation.

F. Proposed substitutions shall not affect dimensions shown on the Contract Document except as submitted for review and approved by the Owner.

G. Any redesign or construction costs required to integrate the proposed substitution shall be the responsibility of the Contractor. Any costs incurred by the Owner, Owner's representatives, Architect, Engineers or Consultants attributable to the integration of a proposed substitution shall be borne by the Contractor.

H. Any proposed substitution shall have no adverse effect on other trades, the construction schedule or specified warranty requirements.

I. The functionality, performance, general appearance and quality of the proposed substitution shall be equivalent to or superior to those of the specified item.

J. Any change to the Contract (deductive or additive cost) associated with a proposed substitution shall be submitted to the Owner for review at the time the substitution is proposed and accompanying a substitution request documentation.

K. The Contractor shall provide the same warranty for the substitution that the Contractor would for the specified product.

L. The Contractor shall coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects equal to the designed system before the substitution was made. In the event that the substituted material or equipment fails to meet performance testing standards after installed, the Contractor shall replace substituted material or equipment with those initially specified.

PART 3 - EXECUTION

3.01 GENERAL

A. Perform the Work of this Section in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.

B. Furnish and install (herein, "provide") all materials, devices, components, and equipment required for complete, operational systems.

C. Contractor is to supervise the installation of back boxes and terminal cabinets installed by the Division 26 Contractor. Contractor is to verify that correct boxes are installed in their proper locations before any drywall has been installed.

3.02 EXAMINATION

A. Immediately report to the Consultant any discrepancies between the specifications and drawings. This includes discrepancies between the technical specification documents and actual field dimensions or findings that may hinder installation work, conflict with other trades, or cause delays.

B. Carefully examine all details that affect all aspects of the systems described in the specifications and drawings.
   1. Examine, coordinate and confirm all drawings and details.
   2. Examine, coordinate and confirm all electrical power requirements, conduits, raceways, boxes, and etc.
   3. Examine, coordinate and confirm work of other trades that may influence the outcome of the design, specification, and performance of the systems.

3.03 PREPERATION

A. This installation section is only meant as a guideline for the Contractor. The Contractor shall be responsible for executing all installation work in a manner that is in accordance to industry-accepted standards or governing codes, whichever is more stringent. Installation activities shall be executed in an organized and orderly manner. These steps include, but are not limited to, pre-delivery testing, delivery, unloading, installation, equipment / cable labeling, programming, set-up / calibration / alignment / adjustment, testing, commissioning, training, and documentation.

B. Protect all existing work surfaces, furniture, equipment, fixtures and etc. before commencing installation work. Any damage to the existing physical and electrical property due to installation work shall be the responsibility of the Contractor.

C. Immediately hand over any de-installed equipment to the Owner for safe-keeping if equipment is to be reused.

D. Carefully remove any obstructions such as fixed seating, ceiling tiles, furniture, equipment and etc. that would obstruct or hinder the installation work. Damage caused by undue care in moving these items shall be responsibility of the Contractor.

E. Examine, coordinate, and confirm the cleanliness of the work site before commencing the portion the installation work that involves dust-sensitive electronic or electrical equipment such as audio mixers, switchers, projectors, control processors, computers, cameras, etc. Dust-sensitive equipment that is installed in a work site with air borne dust and dirt shall be properly protected. For example, a video camera on a wall-mounted bracket is protected by a clean plastic bag to prevent dust from contaminating it. Seal the bag’s opening using adhesive tape.

F. Prior to commencing installation work, ensure that the surrounding areas are clean and promote ease of installation work.

G. Ensure that all equipment rack and equipment locations are clean before commencing installation work.

H. Unless specified otherwise, furnished products / equipment shall be tested, delivered and installed. And, all systems shall be tested and commissioned to fully operational and properly configured condition.

I. All electrical equipment shall be burned-in or tested at the Contractor’s shop before delivery. This pre-installation test shall reveal any equipment that is faulty, malfunctioning, or dead out of the box ahead of time.

J. All radio frequency (RF) operated devices shall be tested on-site prior to installation to determine blind spots, RF interference, or any other transmission / reception problems. The Contractor shall be responsible for costs associated with providing additional support or accessory equipment (antennas, amplifiers, cables, etc.) and / or services to improve signal transmission / reception.

K. Provide all support equipment (ladders, man-lifts, tools, etc.) required to complete the installation work in a safe and expeditious manner.

L. Obtain any plan approvals, permits and licenses required by inspection authorities prior to execution of any installation work. The Contractor shall be responsible for all associated fees and costs incurred while fulfilling this requirement.

M. Ensure that all equipment is accessible for operation and maintenance work. Under no circumstance shall equipment be inaccessible or inconveniently located.

N. Aside from the systems' operational features, provide equal attention to the overall aesthetics of the installed equipment and cabling. Special attention to aesthetics shall be extended to equipment or cabling in public spaces.

O. Firmly secure all fixed equipment and hardware in place and ensure that they are plumb and / or square. An exception to this shall be portable or movable equipment.

P. Structurally mounted equipment: All equipment shall be mounted in accordance to all applicable safety codes, standards and practices. The one that provides for the most stringent rule shall prevail. All mounting hardware shall have a load rating by, at least, a factor of 5 (500% or greater) in reference to the weight of the equipment to be mounted or suspended. An exception to the rule shall be existing local safety codes or standards requiring greater load capacities.

Q. Seismic restraints: Abide by all the seismic restraint requirements described in all applicable building codes in force at the work site. If no provisions exist for a particular situation, follow these minimal recommendations.
   1. Fixed equipment: Mount and brace to the building structure to minimize potential hazards to personnel and damage to property during any kind of seismic event.
   2. Floor mounted equipment: Bolt equipment securely to the floor to prevent from toppling during any kind of seismic event.
   3. Vertical-mounted columns: Apply braces to the vertical column in four opposing directions back to the mounting surface. This will minimize sway in any direction. Provide a separate, flexible restraint (e.g. aluminum braided aircraft cable) with a capacity of 5 times the weight of the total mounting system. The same applies to the anchor to which the flexible restraint is attached and the method of attachment to the structure.
   4. No equipment, equipment supports, or mounts must fail before the structure fails.
   5. Seismic restraint measure must not interfere with fire stopping.
   6. Notwithstanding compliance with these minimum recommendations, it is the Contractor's responsibility to ensure that the seismic restraint measures taken are adequate for the circumstances, including, if required, verification by an independent structural engineer. The cost of all such engineering shall be the responsibility of the Contractor.
   7. Penetration of the Slab: Verify that any mounting or restraint work that requires deep or thorough penetration of the slab shall not damage embedded materials including, but not limited to, slab tensioning devices or conduit. Verify the slab by X-ray or other method before proceeding. The Contractor shall be responsible for all costs associated with this investigation.

3.04 INSTALLATION

A. Follow manufacturer's instructions for installing, operating, configuring, and programming their equipment. Do not perform modifications to equipment that would void its warranty.

B. Pull and terminate all cables and interconnect all equipment and components in accordance with approved drawings. Install audio-visual cover plates and faceplates onto all boxes.

C. Loudspeaker Assembly Installation
   1. Loudspeakers:
      a. Verify proper installation of loudspeaker enclosures and related support.
      b. Verify that no loudspeaker assembly is subjected to stresses or loading effects in any way contributing to possible extraordinary failure.
      c. Connect loudspeaker assemblies to the appropriate 70 volt-line transformer tap as applies. Verify specified polarity. Use insulated crimp connectors or insulated "bobtail" splices applied with manufacturer's recommended ratchet tooling. Wago Wall-Nuts 773 Series or equal are acceptable. Wire nuts or "Scotchlock" connectors shall not be acceptable.
      d. Verify that loudspeaker grille openings and loudspeaker components are clear of paint after finishing.
      e. Perform preliminary loudspeaker tests specified herein. Correct non-conforming conditions.
      f. Adjust 70 volt-line transformer taps as required to realize uniform sound pressure level as specified herein. Document final 70 volt-line transformer taps on the Record Drawings.
      g. Correct all conditions giving rise to noise, rattle or other extraneous sounds owing to operation of a loudspeaker assembly under any specified operating condition.
   2. Packaged Loudspeakers:
      a. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of packaged loudspeakers. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Submit in timely manner.
         1) Comply with applicable Code and the requirements of the Authorities having jurisdiction.
         2) Provide safety factor greater than six or as required by Code, whichever is greater.
      b. Mounting shall:
         1) Permit each packaged loudspeaker to be re-oriented at least plus or minus 5o from angles shown on the Contract Drawings for optimum coverage.
         2) Maintain precise location and orientation of each packaged loudspeaker component after such adjustment when subject to vibration of loudspeaker components due to operation at full specified system output level, and when subject to normal building motion and Code defined seismic induced building motion.
         3) Use rigid metal support members, such as threaded rod with locking nuts.

c. Test each packaged loudspeaker prior to installation at design locations. Test at least polarity and freedom from buzzes, rattles and objectionable distortion, using procedures specified herein. Correct non-conforming conditions.
d. Do not apply any load to building structure without first obtaining written approval of the Owner. Obtain per Project procedures.
e. During Acceptance Testing, adjust orientation of packaged loudspeakers as directed to achieve optimum coverage. Provide workers and ladders as required. Perform such adjustment with no claim for additional cost or time.
f. Do not suspend or orient the loudspeaker cluster prior to verification by the Owner or Owner's representative, that the intended location is correct with respect to as-built conditions such as the final dimensions of the space.

D. Video Projectors
1. Projectors shall be centered laterally to the projection screens.
2. Projectors shall be mounted such that digital keystone compensation will not be required.
3. Projectors shall be mounted such that their optical zoom settings shall not be set at either their widest nor narrowest extreme, but shall be used in their mid-range.

3.05 LABELING AND IDENTIFICATION

A. All cables and connecting blocks shall be clearly, logically and permanently marked and identified by the following means:
1. Use cable labels similar to the Panduit Polyolefin Self-laminating Labels for inkjet or LaserJet printers or any other means acceptable to the Consultant. Cable labels should be machine printed and not handwritten.
2. Cable labels should be placed approximately 12 cm. from each end of the cable.
3. Labeling conventions shall be clear, logical, and must be acceptable to the Consultant.
4. Include all cable identification numbers on all wiring diagrams and cable schedules.
5. For fiber optic cables, use cable identification products such as the Panduit Label Core series or any other means acceptable to the Consultant.
6. For connector and terminal blocks, label using Wago, Phoenix or any means acceptable to the Consultant.

B. All cover plate, switches, panels, outlets, etc. labeling shall be engraved and filled, or silk-screened or by any other means acceptable to the Consultant. Do not use Dymo, Brother Ptouch, or other similar labeling products.

C. Protective Devices
1. Identification of fuses and circuit breakers shall indicate protected circuitry, rating of protective device and voltage across open circuited protected device.

D. Panels and Receptacles
1. Panel surfaces shall be engraved and filled or silk screened with identification, or shall be provided with 1/16 inch (minimum) thick laminated plastic labels with engraved block characters at least 1/8 inch high fastened to the equipment by

stainless steel screws or rivets. Provide white characters on black background unless otherwise noted. Do not use Dymo, Brother Ptouch, or other similar labeling products.

E. All equipment shall be labeled in a clear, logical manner or by any other means acceptable to the Consultant.
   1. For equipment identification, use 'badges' made of aluminum or plastic or any other acceptable material with engraved and filled, or silk-screened labeling. Stick these badges using industrial-strength doubled-sided 3M adhesive tape. Label schemes should be clear, logical, and simple or by any other means acceptable to the Consultant. Indicate equipment labeling schemes on all elevation and plan drawings showing the front and / or rear of the equipment racks. The reader should be able to easily reference the label description to specific equipment in the Operation and / or Maintenance Manuals. Do not use Dymo, Brother Ptouch, or other similar labeling products.

3.06 WIRING

A. General
   1. This section does not apply if the drawings incorporate a wire schedule.

B. Audio Signal Wiring Classification:
   1. Type A-I: Microphone level wiring less than -30 dBu, 20 Hz to 20 kHz.
   2. Type A-2: Line level wiring -30 dBu to +24 dBu, 20 Hz to 20 kHz.
   3. Type A-3: Loudspeaker level or circuit wiring greater than +24 dBu, from 20 Hz to 20 kHz.

C. Video/Graphics and Related Signal Wiring Classification:
   1. Type V-1: Baseband and composite video wiring 1 volt peak-to-peak into 75 ohms, 0 to 100.0 MHz.
   2. Type V-2: Synchronization and switching pulse wiring 4 volts peak-to-peak into 75 ohms, 15.62 to 15.75 kHz.
   3. Type V-3: Color subcarrier wiring 0 to 4 volts peak-to-peak into 75 ohms, 3.57 to 4.43 MHz.

D. Control Signal Wiring Classifications:
   1. Type C-1: DC control wiring 0 to 50 volts.
   2. Type C-2: Synchronous control or data wiring 0 to 40 volts, peak-to-peak.
   3. Type C-3: AC control wiring 0 to 48 volts, 60 Hz.

E. Additional Wiring Classifications:
   1. Type M-1: DC power wiring 0 to 48 volts.
   2. Type M-2: AC power wiring greater than 50 volts, 60 Hz.

F. Wiring Combinations: Except as indicated herein, conduit, wire ways and cable bundles shall contain only wiring of a single classification. The following combinations are acceptable in conduit, or cable harnesses. Additional acceptable combinations may be indicated on the Contract Drawings.
   1. Types A-1, C-1, and M-1.
   2. Types A-2, C-I, C-2, and M-I, runs less than 20 feet.
   3. Types A-2, C-1, and M-1.
   4. Types A-3, C-1, C-2, and M-1.

5. Types A-2, V-1, and V-3.
6. Types V-1, V-2, V-3, and C-1.
7. Types M-2 and C-3.

3.07 WIRE AND CABLE INSTALLATION

A. Provide permanent identification of run destination at all raceway terminations.

B. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.

C. All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels, connector shell or equipment enclosures.

D. Within buildings, make splices only in designated terminal cabinets and/or on designated equipment backboards. Outside buildings, make splices only in designated manholes and/or hand holes. Protect splices outside of buildings with splicing kits equivalent to Scotch-cast Re-enterable. Make splices only with connectors or terminal devices specified herein. Document all splices on Record Drawings.

E. Verify that all raceway has been de-burred and properly joined, coupled, and terminated prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.

F. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.

G. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.

H. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Provide tool formed thermal expansion loops at cable at manholes, handholes and at both sides of all fixed mounted equipment. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.

I. Secure all wire and cable run vertically for continuous distances greater than 30 feet. Secure robust non-coaxial cables with screw-flange nylon cable ties or similar approved devices appropriate to weight of cable. For all other cables, provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable.

J. All Category type cable, connectors and plugs shall be color coded for easy visual distinction. Color coded insert type boots shall be installed on all Category type plugs. A colored coded ring will be provided on all chassis connectors (i.e. Neutrik ACRF-#). Cable connecters shall be equipped with Neutrik BSE-# color coded bushings. The Color code shall be as follows if there is no standard, coordinate this effort with client:
   1. Data LAN = Yellow
   2. HDBaseT = Green

3. Audio Network = Red
4. AV LAN = Orange
5. KVM-USB Extenders = Grey
6. AV UTP = White
7. AV STP = Blue

3.08 CONNECTOR AND SIGNAL POLARITY CONVENTION

A. Maintain consistent absolute signal polarity at all connectors, patch points and connection points accessible in the system. Where applicable, a positive polarity electrical signal shall yield positive acoustic pressure from the loudspeakers.

B. Audio signal connector convention: AES14-1992 (ANSI S4.48-1992) AES standard for professional audio equipment - Application of connectors, Part 1, XLR-type polarity, and gender.

Signal	Connector	Wire
Signal Phase	Pin 2	Red or White
Signal Anti-Phase	Pin 3	Black
Signal Ground	Pin 1	Drain Wire

C. Video and RF/MATV Connector Convention:

Signal	Connector	Wire
Signal Phase	Center Pin	Center conductor
Signal Anti-Phase	Shell	Shield
Signal Ground	Shell	Shield

D. Voice/Data Connector Convention: Comply with EIA/TIA-568C.

E. Speaker Patch Panels: These panels shall be loaded with Neutrik NL4MP panel jacks. Wire amplifier side to +1 & -1, wire speaker side to +2 & -2. Provide crossover patch cables for each amplifier. These crossover cables will prevent amplifier to amplifier connections.

3.09 WIRING PRATICE

A. Land all non-coaxial field wiring entering each equipment rack at specified terminal devices prior to connection to any equipment or devices within racks. At Contractor's option, such terminals may be located in the equipment racks or at backboards provided. Coordinate such selection with Project construction sequence and test procedures specified herein.

B. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one inch of each connection. Indicate the number designated on the associated field or shop drawing or run sheet, as applies. Assign wire or cable

designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Provide any of the following:

1. Continuous permanent imprint; equivalent to Clifford of Vermont, Inc. "Quik-Pull".
2. Direct hot stamp.
3. Heat shrinkable factory hot stamped; equivalent to Brady sleeve Heat shrink.
4. Adhesive strip printed labels wrapped the full circumference of the wire and sealed with clear heat shrink tubing; equivalent to Thomas and Betts or Panduit Insta-code with clear heat-shrunk tubing equivalent to Alpha.

C. Apply all crimp connectors only with manufacturer's recommended ratchet type tooling and correct crimp dies for connector and wire size. Plier type crimp tooling shall not be acceptable.

D. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.

E. Make all connections to screw-type barrier blocks with insulated crimp-type spade lugs. Lugs are not required at captive compression terminal type blocks. Provide permanent designation strips designed for use with the terminal blocks provided. Make neat, intelligible markings with indelible markers equivalent to "Sharpie".

F. Tin terminated shield drain wires and insulate with heat shrinkable tubing.

G. Use only rosin core 60/40 tin/lead solder for all solder connections.

H. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.

I. Termination and build out resistors and related circuit correction components shall be visible. Do not install in connector shells or internally modify equipment. Show locations on Record Drawings.

J. Correct any and all of the following unacceptable wiring conditions:

1. Deformed, brittle or cracked insulation.
2. Insulation shrunken or stripped further than 1/8-inch away from the actual point of connection within a connector, or on a punch block.
3. Cold solder joints.
4. Flux joints.
5. Solder splatter.
6. Non-grommet, non-bushed, or non-insulated wire or cable entries.
7. Deformation or improper radius of wire or cable

3.10 SIGNAL GROUNDING PROCEDURES

A. Comply with National Electrical Code.

B. Unless otherwise noted maintain a unipoint ground scheme.

C. Signal and electrical system grounds shall be isolated except at the Project ground field connection.

D. Equipment enclosures shall not be permitted to touch each other unless bolted together and electrically bonded.

E. Ground and bond equipment racks and similar equipment enclosures containing powered equipment exclusively via the Isolated Ground conductors provided under Division 26. INSULATE RACK MOUNTING, ANCHORAGE, AND RACEWAY CONNECTIONS.

F. At each rack, provide an Isolated Ground bus within the rack. At each rack, provide a lug bonded to the rack frame with a #8 TW stranded wire to the rack Isolated Ground bus.

G. At each ensemble of racks, provide a single labeled Isolated Ground tubular-clamp bus bar terminal strip to land the individual rack Isolated Ground bus ground conductors. Connect the main Isolated Ground conductor from the Technical Power panel board at this point.

H. Equipment signal ground shall be to the Isolated Ground System via the green wire of the equipment power cord. Where equipment uses two wire power cord, provide #12 green bond wire to rack IG bus bar. At equipment, provide crimp lug and suitable hardware for bonding.

I. Shielded cables of this section shall be grounded exclusively to Isolated Ground by a single path. Shield shall be tied to Isolated Ground at one end only, i.e., at the low potential (receiving) end of run, unless otherwise noted.

J. Unless otherwise noted, at audio jackfields, tie source shield at jackbay frame. Float shields at connections to output jacks. Bus each row of jack frames and run individual #12 green ground wire for each row to rack IG bus bar.

K. Signal Ground provisions shall realize less than 0.15 ohms to the primary ground connection.

3.11 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.

B. Within each equipment enclosure, provide a full-height multi-circuit ISOLATED GROUND outlet strip with branch circuit count as shown on drawings; locate on the left side of the equipment enclosure, as viewed from the rear. In each enclosure provide number of receptacles required by present and future equipment indicated on drawings, plus at least two spare receptacles. Provide flexible steel raceway and junction box for connection of power service. Bond internal raceway to rack frame.

C. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.

D. Maintain separation of wiring classifications as specified herein. Separately dress, route and land microphone and line level cables and related on the right side of the equipment enclosure, as viewed from the rear; dress, route, and land loudspeaker level and control cables on the left side of the equipment enclosure, as viewed from the rear.

E. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.

F. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.

G. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels which will remain in place when active equipment is removed for possible service.

H. At jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contacts for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible without cutting apart the harness.

I. Coordinate the design and execution of wire harnessing of multi-bay rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.

J. At each equipment backboard, provide UL Listed surge suppressing multi-outlet assembly with at least six receptacles.

3.12 ADJUSTING AND TESTING

A. Test Equipment
   1. Furnish, store and maintain test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section. Maintain all test equipment at the job site while work is in progress from installation of equipment racks until Owner Acceptance of this Work; thereafter remove all of this test equipment from the job site. Provide all required test cables, jigs and adapters. Provide at least one of the following items or approved functional equivalents:
   2. Audio Systems:
      a. Wide Band Oscilloscope (Tektronix THS700 Series).
      b. True RMS Analog / Digital Volt-Ohm Multimeter (Fluke 187 Series or equal).
      c. Low Distortion Audio Frequency Sine Wave Oscillator (Gold Line TS1).
      d. Measurement Microphones (Earthworks M30, Bruel & Kjaer 4007, Josephson 550).

e. Sound System Optimization and Acoustic Measurement Analyzer (Goldline TEF, Meyers SIM, SIA Smaart, WinMLS, EASERA).
f. Harmonic Distortion Analyzer (Sound Technology or Tektronix AA 501A) or Swept Spectrum Analyzer, HP 3580A, or Swept Test System, Audio Precision or Neutrik).

3. Video Systems:
   a. Wide Band Oscilloscope (Tektronix THS700 Series).
   b. Sync & Test Generator (Tektronix 1470).
   c. Waveform/Vector Monitor (Tektronix 1740).
   d. Color Picture Monitor, Precision.
4. Communications and Related:
   a. Level II, Cat5e Cable Pair Tester (Microtest, HP, Scope, Fluke or Siemons set up to meet Category 5e parameters).
   b. Outside Plant Voice Cabling Plant Tester – capable of detecting shorts, opens, reversals, mis-wiring and crosstwists (Siemon STM-8 or equal by Mod-Tap).
   c. Metallic cable pair tester (Wavetek Corporation, Instruments Division, model LANTech 100).
   d. Tone Test Set.
   e. Optical Time Domain Reflectometer (OTDR) for fiber optics.
   f. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.

B. System Performance Testing and Adjusting Procedures
1. Upon completion of the installation of all equipment in an area, perform the following tests and record results. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Correct all non-conforming conditions prior to requesting Acceptance Review and Testing. Perform at least the following procedures:
2. Mechanical: Verify:
   a. Integrity of all support provisions.
   b. Absence of debris of any kind, tools, etc.
3. Power and Isolated Ground: Verify:
   a. Isolation of Isolated Ground system from raceway and related ground.
   b. Grounding of devices and equipment. Integrity of signal and technical power system ground connections.
   c. Proper provision of power to devices and equipment.
4. Signal Wiring: Verify:
   a. Integrity of all insulation, shield terminations and connections.
   b. Integrity of soldered connections. Absence of solder splatter, solder bridges.
   c. Routing and dressing of wire and cable.
   d. Continuity, including conformance with wire designations on running sheets, field, and shop drawings.
   e. Absence of ground faults.
   f. Polarity.
5. Use the proper sequence of energizing systems to minimize the risk of damage.
6. Audio Systems:

a. Electronic Tests; confirm:
   1) Gain at 1 kHz.
   2) Maximum output.
   3) Input clipping level.
   4) Frequency response.
   5) Total harmonic distortion.
   6) Signal-to-Noise ratio.
   7) Signal-to-Crosstalk ratio.

b. Electro/Acoustic Tests:
   1) Uniformity of coverage.
   2) Electronic and acoustic frequency response/one-third octave equalization. Transfer function measurement shall be as close to flat as possible. Measure at ear level. Representative of the Owner will direct final adjustment.
   3) Maximum continuous sound pressure level (in the reverberant field). Drive systems with broadband pink noise. Sustain for at least five minutes with no system damage. Measure for "A" and "C" weightings at ear level on loudspeaker axis. Turn off noise.
   4) Acoustic signal-to-noise ratio referenced to the specified maximum continuous sound pressure level in the reverberant field. Measure for "A" and "C" weightings at ear level on loudspeaker axis with mechanical systems operating. Present comparison with previous measurement.
   5) Acoustic gain before feedback. Locate acoustic source (4 inch loudspeaker/pink noise generator) two feet from system microphone. Measure at system microphone position and at most distant listener position at ear level. Present comparison.

7. Video Systems:
   a. Video Monitors:
      1) Apply crosshatch. Verify linearity.
      2) Apply red field. Adjust purity.
      3) Apply SMPTE bars and PLUGE. Adjust to standards.
   b. Video Path Test: Use NTC-7 procedures. Use full field or line signals. Alternately, conduct copper time domain reflectometer test.
8. Fiber System:
   a. Fiber:
      1) Conduct optical loss test.
      2) Conduct optical time domain reflectometer test.
9. Diagnostic Monitoring System:
   a. Demonstrate complete operation.
10. System Overall:
   a. Verify levels.
   b. Provide permanent "wedge" type labels on all controls, as applies, to indicate correct settings after systems performance testing and adjustment procedures have been successfully completed.

C. Loudspeaker Assembly Testing and Adjusting Procedures
1. Upon completion of the installation of all loudspeakers in an area, perform the following tests and record results. Correct non-conforming conditions, unless the cause is clearly outside the Work of this Section, in which case submit the apparent cause to the Owner.

2. Loudspeaker Line Impedance: At terminal cabinets at equipment rooms, measure the impedance of each loudspeaker line. Sweep from at least 20 Hz to at least 16 kHz.
3. Loudspeaker Polarity: Test the acoustic polarity of all loudspeakers using an Acoustic Polarity Tester.
4. Freedom From Buzzes, Rattles and Objectionable Distortion: Individually apply to each loudspeaker line a slow sine wave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles and objectionable distortion.
5. Uniformity of Coverage: Apply broadband Pink Noise. Adjust level to approximately 70-80 dBA at measurement locations. Measure in 4 kHz octave band at ear level. Adjust loudspeaker aiming and 70 Volt loudspeaker taps for uniformity of coverage.

D. Equipment Rack and Equipment Testing and Adjusting Procedures
1. Conduct procedures in fabrication shop. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report with color photographs of each equipment rack, front and back. Request and coordinate verification of submitted test data by the representative of the Owner. Correct all non-conforming conditions prior to shipment to Project Site. Perform at least the following procedures:
2. Preliminary: Verify:
   a. Grounding of devices and equipment. Integrity of signal and electrical system ground connections.
   b. Proper provision of power to devices and equipment.
   c. Integrity of all insulation, shield terminations and connections.
   d. Integrity of soldered connections. Absence of solder splatter, solder bridges.
   e. Absence of debris of any kind, tools, etc.
   f. Routing and dressing of wire and cable.
   g. All wiring, including polarity and continuity, including conformance with wire designations on running sheets, field and shop drawings.
   h. Mechanical integrity of all support provisions.
3. Rig temporary power and grounding: Comply with all applicable Codes, regulations and ordinances.
4. Determine the proper sequence of energizing systems to minimize the risk of damage. Energize. Burn in for at least 120 hours.

E. Telecommunications Cabling Testing
1. Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.
2. Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-

568-C.1, TIA-568-C.2 and TIA-568-C.3. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.

3. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connected.
4. For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568- C.3 and TIA-526-14-A using Method A, Optical Power Meter and Light Source for multimode optical fiber. For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568- C.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source]. Perform verification acceptance tests.
5. Perform testing for each outlet as follows:
   a. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA/EIA-568-B.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
   b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568-C.3. E. Final Verification Tests
   c. Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

3.13 CLEANING

A. Clean each section or area of where the work was conducted after completion to permit immediate use of the area. Remove and discard all refuse, rubbish, and debris.

B. The Contractor shall ensure that all recyclable and environmentally hazardous waste materials are disposed properly.

C. Make good all existing structures, surfaces, and utilities affected by cutting, coring, mounting, drilling, or other new work.

D. Clean all furnished equipment of dust, dirt, fingerprints, smudge, and other material prior to calling for a Substantial Performance of Work Review or Completion of Work Review.

3.14 PROTECTION

A. During the installation phase and up to the date of achieving Substantial Performance of Work, protect finished or unfinished work against damage or loss. In the event of such damage or loss, immediately replace or repair such work or equipment at no cost to the Owner.

3.15 ACCEPTANCE REVIEW, TESTING PROCEDURES AND COMMISIONING

A. Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Owner in writing that the Work of this Section is complete and fully complies with

the Contract Documents. Request Acceptance Review and Testing by returning Attachment "A" to the Design Consultant. The representative of the Owner will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These Procedures may be performed at any hour of the day or night as required by the representative of the Owner to comply with the Project Schedule and avoid conflict with these procedures from possible ongoing work of other Separate Contracts and/or the Owner's operations. Provide all specified personnel and equipment at any time without claim for additional cost or time.

B. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this Section. Provide quantity of technicians as required to comply with Project Schedule.

C. In Addition, Provide:
   1. Set of hand and power tools appropriate for performance of adjustment of and corrections to this Work.
   2. Include spare wire and connectors and specified tooling for application.
   3. Ladders, scaffolding and/or lifts as required to access loudspeakers and other high devices.
   4. Test equipment to include but not limited to:
      a. Dual channel FFT-based audio analyzer
      b. Video test generator with color bars, grayscale, alternating pixel, multi-burst, crosshatch and % windows.
      c. InfoComm Projection Shoot-Out DVD
      d. Digital Video Essential Professional DVD
      e. Category cable tester, cable length, short, open and miswire test.
   5. Complete set of latest stamped, actioned submittals of record for reference.
   6. Complete set of Shop and Project Site Test Reports.
   7. Complete set of manufacturer's original operation, instruction, and service manuals for each equipment item for reference.

D. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.
   1. General
      a. Configure room for each type of event and demonstrate audio-visual system.
      b. Connection of portable equipment. (Laptop, document camera, etc.)
      c. Demonstrate to the Consultant that all functions and equipment for the system work properly when installed as a complete system.
      d. The Contractor shall demonstrate the satisfactory operation of all controls and adjustment circuits of the system.
      e. Demonstrate system startup and shut down procedures.
   2. Audio
      a. Route audio to program speakers.
      b. Route audio to monitor speakers.
      c. Patch each audio tie line into system.
      d. Route audio signal to auxiliary speakers.
      e. Connect microphone to each panel input and route through system.
      f. Demonstrate and document gain structure through the system.
      g. Demonstrate and document with a dual channel FFT-based audio meter the following:
         1) Polarity of each driver in each cabinet.

2) Crossover point of high, mid and low section of each loudspeaker.
3) dB SPL levels from 1-4 kHz at various position in the audience area.
4) dB SPL level of high, mid, low and sub frequency bandwidth at crossover.
   a) Audio routed to ceiling speakers.
   b) Audio Conferencing.
   c) Wireless microphones.
   d) Demonstrate that the audio system is properly time aligned and equalized.
   e) Assistive listening system.
   f) Production intercom system.

3. Video
   a. Route source equipment (DVD, TV tuner, test generators, etc.) to video displays and projector.
   b. Set up room for each type of event that may take place and demo each.
4. Control
   a. Communication between control system and AV equipment, including feedback if device supports 2-way communication
   b. User interface operation.
   c. Password protection of user interface.
   d. Video conference remote control.
   e. Touch panel features and each page of control.
   f. Touch panel help file.
   g. Help desk features.
   h. All programmed presets.
5. The Contractor 's personnel and test equipment shall be made available to the Consultant in order that:
   a. Selected tests and measurements previously made by the Contractor can re-run.
   b. Other tests may be made at Consultant's discretion.
   c. Additional tests or measurements may be made due to changes in field conditions.
6. It is estimated that the acceptance tests and demonstrations will require approximately four hours unless construction or installation problems or deviations from the specifications are discovered.

E. Adjust: As directed by the representative of the Owner.

F. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the representative of the Owner.

G. Acceptance Documentation
1. Official acceptance of the system covered by this specification will occur when the Design-Builder receives the following written documents:
   a. A letter from the Consultant to the Architect acknowledging Final Acceptance of the system stating compliance with all articles of the specifications.
   b. A letter from the Architect to the Contractor stating that all related work has been completed to his satisfaction. Until these documents are received, the installation is not formally complete. The official date of acceptance shall be the date of the letter from the Architect to the Contractor described above.

3.16 CLOSEOUT

A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify Owner of completion of Punch List.

B. Portable Equipment: Furnish all portable equipment and spares to the designated representative of the Owner, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.

C. Operating and Maintenance Data: Install framed operating and maintenance instructions. Submit Manuals.

D. Project Record Documents: Submit.

E. Keys: If applicable, replace construction locks with permanent locks. Transmit keys to Owner.

F. Training: Conduct specified training and submit training manuals.

G. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

3.17 OWENER’S RIGHT TO USE EQUIPMENT

A. Acceptance of the Work of this Section will be after completion of corrections and adjustments required by the "Punch List" which results from Acceptance Review and Testing of the completed installation. The Owner reserves the right to use equipment, material and services provided as part of the Work of this Section prior to Acceptance without incurring any obligation to Accept any equipment or completed systems until all Punch List work is complete and all systems comply with the Contract Documents; or accept any claim for additional cost or time.

Attachment "A"

NOTICE OF COMPLETION
&
REQUEST FOR FINAL INSPECTION

We hereby give notice that the work associated with the Audio-Visual system, at the project named below, is completed and fully complies with the contract documents issued to the Contractor. The required submittals below have been marked as completed.

- ☐ Programming
- ☐ Test Reports
- ☐ Operation Manual
- ☐ Maintenance Manual
- ☐ Training Manual
- ☐ Training
- ☐ Warranty Certificates
- ☐ Record Drawings

We request commissioning and verification testing be scheduled with the Owner's Representative for final system sign off. Attached is a list of test equipment for review and acceptance.

PROJECT INFORMATION

Project Name:	Project Phase:	
Project Address:		

CONTRACTOR INFORMATION

Name:	Company:	
Address:		
Signature:	Date:	

Note to Contractor: Provide all test equipment for final inspection as described in the specification.

Please complete and fax or email this form to
Veneklasen Associates attention AV Department
Fax (310) 396-3424 Email dyoung@veneklasen.com

END OF SECTION

SECTION 27 51 14 - INTERNET PROTOCOL OVERHEAD PAGING SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of an Internet protocol overhead paging system.

1.02 RELATED DOCUMENTS

A. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them, including but not limited to the following.
   1. Section 28 46 21.11 - Addressable Fire Alarm System.

1.03 SYSTEM DESCRIPTION

A. The overhead paging system shall provide.
   1. Network base signal transport and control.
   2. Storage and playback of prerecorded messages
   3. Provide sound coverage of the areas indicated on the drawings
   4. Interface to telephony system for paging initiation.
   5. Interface to handheld microphones for paging initiation.
   6. The system shall allow the following.
      a. One-way paging by zone.
      b. Fire alarm system override.
      c. Distribution of background music.

B. The system shall interface to the existing system to allow building wide paging.

C. This section includes but is not limited to the following equipment and the associated installation thereof.
   1. Loudspeakers.
   2. Network switches (Owner provided).
   3. Mounting Brackets
   4. Conduits.
   5. Cable provided under Section 27 15 00 Work.
   6. Patch cords [refer to Section 27 15 00 Work].
   7. Software & programming.
   8. Testing.
   9. Final adjustment.
   10. Documentation.

1.04 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. POE: Power over Ethernet standard that pass data and power over a structured network cable connection from a POE network switch.

C. SIP: Session Internet Protocol is a signaling protocol used for initiating, maintaining, modifying and terminating real-time communications sessions between Internet Protocol (IP) devices.

D. Virtual Private Network (VPN) - Secure passage of network traffic over the network.

E. VoIP: Voice over Internet Protocol technology that allows voice calls using a broadband Internet connection in lieu of an PBX or analog phone line.

F. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.05 ACTION SUBMITTALS

A. Manufacturer’s Instructions:
   1. Submit application conditions and limitations of use stipulated by the manufacturer.

B. Product Data:
   1. System data.
   2. Materials list.
   3. Technical data (cut sheets) for on each component, including finishes and weights.
   4. Manufacturer’s instructions for storage, handling, protection, examination, preparation, operation, and installation of product.

C. Equipment design considerations for future expansion when indicated.

D. Shop Drawings:
   1. Description of system operation.
   2. Conduit and back box schedule (including unique back boxes).
   3. Coordinated reflected ceiling plan views for all devices shown on floor plans.
   4. Test Reports: Indicate procedures and results for specified field testing and inspection.
   5. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
   6. Installation plan and schedule.
   7. Training plan and schedule.

E. Deferred Submittals:

1. Network connection requirements.
2. Network address requirements.
3. Manufacture's system installation instructions and programming templates.
4. Cable patching (patch panel to network switch) schedules.
5. System test plan and schedule.
6. System training plan and schedule.

1.06 CLOSEOUT DOCUMENTS AND MATERIALS

A. Refer to Section 27 05 00 - Common Work Results for Communications for additional requirements.

B. Record actual location of system components including the following:
   1. Floor plans with speaker locations, master/lead speaker ID s, MAC addresses and SIP server IP addresses.
   2. Speaker schedules with:
      a. Location.
      b. Zone.
      c. Zone ID.
      d. Master/lead vs follower designation.
      e. Subnet.
      f. VLAN
      g. IP address.
      h. Static/DHCP.
      i. IDF room.
      j. Structured cable ID.
      k. Speaker ID.
      l. Network switch ID.
      m. MAC address.
      n. Unicast/Multicast routing.
   3. Cable and equipment labeling and cable termination schedules.
   4. Zone configuration and zone extensions.
   5. Interface to the existing overhead paging system.
   6. Product data.
   7. Operational manuals.
   8. Maintenance manuals.
   9. Test procedures and results.

C. Warrantees.

D. System service contact information including service desk representative, service desk manager and operations manager.

E. Operating Manuals:

1. Preventive operation instructions for components of the system as a whole and each component in detail. Manual shall include software and hardware operation and programming. Manuals shall be written to aid in training of new security and operating personnel and as a guide in clarifying operational procedures.

F. Maintenance Manuals:
1. Preventive maintenance program and service instructions for components of the system as a whole and each component, function and operation in detail. Manuals shall include illustrations, mounting instructions, wiring diagrams, parts lists, operating instructions, and a trouble-shooting chart for the system, including a list of troubles, causes and recommended remedies.
2. Spare Parts List. Submit a list of spare parts and components of critical items for consideration of purchase by the Owner.

1.07 CONTRACT DRAWINGS

A. The contract drawings indicate the general nature of the system layout, but do not show all components required. Rough-in requirements are shown on the contract drawings but do not show all conduit and back boxes. Conduits, routing and wiring are not shown on the drawings. Provide as per system requirements and shop drawings.

B. Coordinate back box and speaker mounting requirements with system manufacturer/supplier. Refer to the Architectural drawings to understand wall and ceiling construction details. Notify Architect prior to installation if conflicts occur between:
1. Back box depth and wall thickness.
2. Wall construction.
3. Back box location.
4. Ceiling construction.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect material from the entrance of dirt, dust, moisture and debris.

1.09 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer:
1. Company specializing in installing the products specified.
2. Authorized or franchised installer of the specified system with a minimum three years documented experience.
3. Employed technicians are trained and certified by the specified system manufacturer.
4. Employed software technicians are trained and certified by the specified system manufacturer.
5. Located with sales and service facilities with 4 hours travel time of the Project site.

C. System Testing and Adjustment: Qualified technicians with prior knowledge of the items of equipment, and general knowledge of audio systems alignment and troubleshooting, and knowledge of the specific systems and installations of this project.

1.10 COORDINATION

A. Coordinate the installation of the intercom system with the Owner and their network engineers for network port access, provisioning and IP network address requirements.

B. Coordinate the installation of ceiling mounted speakers with the ceiling installation Work. Refer to the Architectural reflected ceiling plan drawings for ceiling details.

C. Coordinate the integration of the overhead paging system with the telephony system for annunciation for paging requests with the Owner IT Staff prior to commencement of any work.

D. Coordinate application server requirements with the Architect and Owner.

E. Coordinate the patching of horizontal cable termination to Owner’s network switches in the communication rooms with the Architect and Owner.

F. Coordinate the installation of speakers with the Section 27 15 00 Communication Horizonal Cabling Work.

G. Coordinate the installation of wall and rack mounted components in the communication rooms with the 27 11 00 Work. Provide information for the completion of Section 27 11 00 Shop Drawings.

H. Coordinate the installation of overhead paging system with the Section 28 46 21.11 Addressable Fire Alarm System Work.

1.11 MAINTENANCE SERVICE

A. Furnish service and maintenance of overhead paging system equipment for one year from the date of Owner Acceptance.

1.12 WARRANTY

A. All equipment shall be guaranteed to be free of defect or faulty workmanship for a minimum period of one year from the date of final acceptance. If any equipment shall fail or found to be inoperative within this period, the contractor shall repair and/or replace within (1) day of the notification with no expense to the owner. Any required maintenance

for the equipment that falls within this warranty period shall also be performed by the contractor at no expense to the owner.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

A. Algo. (Owner Furnished Contractor Installed)

2.02 SPEAKERS

A. UL 2043 rated for use in plenum ceiling and spaces.

B. Support for Session Internet Protocol signaling:
1. Peer to peer.
2. Integrated with SIP/PBX.

C. Open API for software integration.

D. Minimum sound pressure level: 85 db.

E. POE+ powered integrated 7-watt class D amplifier with 8-pin modular outlets.

F. Built in microphone with integrated signal test tone feedback microphone for remote health monitoring and system testing

G. Built in:
1. Digital signal processor.
2. Memory to support pre-recorded messages 256 MB RAM, 512MB Flash
3. Passive infrared sensor motion detection sensor - 20 foot range.

H. Supported protocols: UDP, TCP, TLS, RTP, SRTP

I. Speaker for Classrooms:
1. Algo 8190S Algo InformaCast IP Speaker

J. Ceiling Speaker
1. Algo 8188 Algo InformaCast IP Ceiling Speaker

K. Wall Speaker
1. Algo 8180 Algo InformaCast IP Ceiling Speaker

L. Dual-Sided Display Speaker
1. Algo 8420 Algo InformaCast IP Clock Ceiling Speaker

M. Outdoor Speaker

1. Algo 8186 Algo InformaCast IP Horn Speaker

2.03 CEILING SUPPORT BRACKET

A. Bracket to secure speaker to accessible ceiling tile T-bar or gypboard ceiling joist.

B. Algo part # 8188TBR

2.04 PATCH CORDS

A. By Owner

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing cable and equipment and adjusting equipment. Where no instructions are included with the equipment, follow accepted industry best practices as identified in the BICSI design and installation manual.

B. Keep items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures throughout the life of the project.

C. Comply with Section 27 05 28 for requirements for the installation of cables supports, conduits and pack boxes.

D. Protect cable and equipment from damage, at all times during the construction. Do not install cables and equipment in the communications rooms until the other trades have completed their work in the areas so that the equipment will not be moved or damaged.

Do not install cable and equipment in communications rooms until after plywood backboards have been painted.

E. Clean up and remove all debris generated by installation activities. Keep the communications rooms free of debris at all times.

F. Maintain safe ingress and egress from work areas during the movement and installation

G. Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work.

3.02 PREPARATION

A. Obtain system programming templates from the Manufacturer(s). Coordinate programming parameter options with the Architect and Owner prior to programming.

B. Schedule a meeting(s) with Architect and Owner:
1. Present project planning documents and review, adjust, and prepare final setup documents.
2. Confirm the exact location of network switches, patch panels, equipment, consoles, and speakers.
3. Confirm location of wet/damp rooms scheduled for the installation of speakers.
4. Confirm extent of paging zones.
5. Coordinate zone identification numbers/zone names for system programming.
6. Coordinate how to access to the system annunciate live or recorded messages via the console microphone, cellular phone, VoIP phone station, workstation computer and web browser.
7. Coordinate how messages can be created and recorded.
8. Coordinate how messages can be scheduled and activated to
    a. A speaker.
    b. To a zone.
    c. To a group of zones.
    d. To all zones.
9. Coordinate how speaker volume can be controlled and balanced.
10. Coordinate how the system can be monitored.
11. Coordinate software and license requirements and acceptance.
12. Coordinate default system and devices logins and passwords, and how they will be changed to Owner logins and passwords.
13. Coordinate network switch port requirements to connect equipment into the network.
14. Coordinate network bandwidth requirements and the impact the overhead paging multi-cast traffic will have on the network.
15. Coordinate how virtual private networks shall be established.
16. Coordinate network access control requirements.
17. Coordinate the installation of equipment in the communication room(s).
18. Coordinate equipment and speaker network address requirements.

19. Coordinate equipment, speaker and cable identification labeling nomenclature.
20. Coordinate how speaker identification and zone identification will be provided in a computer-based map view.
21. Coordinate the interfacing of the system with the input/output relay modules with the fire alarm control panel and fire alarm system, and how signal from the fire alarm control panel will temporary shunt/start audio pages

C. Coordinate the Work schedule and the sequence of Work.

D. Coordinate a plan for system testing, startup, and demonstration.

E. Record and share decisions for approval and acceptance by the Architect and Owner.

3.03 INSTALLATION

A. Validate the locations of speakers and the routing of cables and conduits prior to rough-in.

B. Integrate the overhead paging system with the fire alarm system to mute, shunt or override the system when.

C. Ceiling Loudspeakers:
1. Speaker locations indicated on the drawings are approximate and are to be verified depending on other ceiling equipment locations and other conflicting devices to ensure they will work properly. Refer to architectural reflected ceiling plans (RCPs) for additional information including the following.
   a. Accessible ceiling areas.
   b. Gypsum board ceiling areas.
   c. Architectural ceiling areas.
   d. Open ceiling areas.
   e. Lighting fixtures location.
   f. HVAC diffuser locations.
   g. HVAC grill locations.
   h. Access panel locations.
   i. Special molding locations.
   j. Sprinkler head locations.
   k. Fire alarm device locations.
2. Do not support flush speaker enclosures with lay-in tiles or gypsum board. Provide support (using attachments to structural elements and/or metal mounting bars) for mounting brackets so that no perceptible sag will occur once speaker and grille are mounted. Provide seismic (slack wires) supports to the speakers. Seismic connections to structure alone shall not constitute speaker support.

D. Conduit & Sparker Back Boxes:
1. Provide a conduit to speakers to areas with inaccessible ceilings. Comply with Section 27 05 28.

E. Cabling:
   1. Coordinate cable installation requirements with the 27 15 00 cable installers.

F. Provide an input/output relay in the fire command center. Connect the relay with fire alarm control panel.

G. Labeling:
   1. Provide identification labels that are in accordance with the approved equipment schedule and cable termination schedule.
   2. Label IDs shall show equipment location number in correspondence with the as built diagrams.
   3. Provide machine-generated labels on cables in black uppercase lettering on a permanent adhesive, white label stock, covered with a permanent water-resistant sealer. Place labels on both ends of each cable and no more than 6 inches from the point at which the cable is connected to a device so that the labels are parallel with the cable. Install labels so that labels are readily visible. Do not label cables with hand lettered labels.
   4. Room numbers shown on the Drawings are not the final room numbers. Validate the final room numbers with the Architect prior to use in creating termination schedules, cable identification labels, cable record drawings, O&M documentation, and system test reports.

3.04 PROGRAMMING

A. Assist the Owner in setting up software, setting up SIP routing protocols, creating paging groups, pre-recorded messages, play list, schedules, and user profiles for paging access.

B. Set rules for speaker volume control.

C. Set rules for paging source prioritization.

D. Set rules for fire alarm system prioritization.

E. Set rules for relay module shunting of overhead paging during the duration of a fire alarm message or a fire alarm annunciation, and removal of the shunt upon deactivation of the fire alarm system.

F. Set rule for message delay and queuing.

3.05 LICENSES

A. Register, secure and provides licenses to the Owner to provide a fully functioning and integrated system

3.06 FIELD QUALITY CONTROL

A. Provide a quality control and testing and acceptance plan, and an associated schedule to the Architect and Owner, a minimum of 2 weeks before the commencement of the testing. Include tester credentials and test documentation templates.

B. Receive and review horizontal cable.

C. Visually inspect speakers, cable placement, cable termination, patch cords and labeling of all components.

D. Schedule tests with at least seven days' advance notice of test performance.

E. Schedule tests with at least seven days' advance notice of the fire alarm system sequence signal shunting.

F. Use current manufacturers' maintenance or alignment manuals during testing and adjustment procedures.

G. Provide sound levels at the following.
   1. Normal voice paging - 60 dB minimum.
   2. Mechanical spaces - 10 dB above ambient sound levels.

H. Measure and record sound power levels at all speaker locations.

I. Operational Test:
   1. Set up zones.
   2. Calibrate speakers and run remote speaker tests.
   3. Conduct pages from phone, microphone, and computer sources.
   4. Verify boundaries of zones.
   5. Conduct pages to individual zone, to multiple zones and all zones.
   6. Check speaker PIR features.
   7. Fire alarm system shunting.

3.07 STARTUP SERVICE

A. Verify that wiring installation complies with manufacturer's submittal and installation requirements.

B. Complete installation and startup check according to manufacturer's written instructions.

3.08 ADJUSTING

A. Adjust sound levels and adjusting controls to meet anticipated occupancy conditions.

B. Within 3 months of date of Substantial Completion or after one month of patient occupancy, re-adjust the system to suit actual occupied conditions.

3.09 DEMONSTRATION AND TRAINING

A. Provide a training plan to Architect and Owner in advance of commencement of the training sessions. Include trainer credentials, training schedules with quantity of classes and durations and training materials for approval by the Owner.

B. Conduct a walking tour of Project with the Architect and Owner. Describe function, operation, and maintenance of each component.

C. Conduct a 4-hour training session with the Owner to describe and demonstrate
   1. All maintenance and operational aspects of the system.
   2. Messages are created, stored, schedules and activated.
   3. How zones are created and changed.

D. Use submitted operation and maintenance manual as reference during demonstration and training.

3.10 WARRANTY

A. Register and provide proof-of-purchases required to activate Manufacturer's warranty.

B. The warranty shall include labor and equipment to maintain the integrated system in full operation for a period of one year for hardware from the date of Owner acceptance.

C. The warranty shall provide:
   1. A contact number for service call during the warranty period that is answered 24 hours 7 days a week. Service calls made outside of normal working hours and received by an answering service shall be returned within 1 hour.
   2. Standard on-site service calls within 12 hours.
   3. Emergency on-site service calls within 4 hrs.
   4. The end-user will notify the contractor of the appropriate response time required. This warranty may be enhanced by the contractor but cannot be taken away from this supersedes all other warranties.

D. Invoke manufacturer's warranties as necessary during the warranty period. Obtain Return-Merchandise-Authorization for shipping defective material back and receiving replacements materials.

END OF SECTION

SECTION 27 51 56 - ASSISTIVE LISTENING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work under this section includes all final design, all labor, material, equipment, supplies, labor, testing, and accessories required to furnish and install a complete permanent Assistive Listening System (ALS) as indicated on the drawings and as specified herein.

1. Provide portable receivers in quantities as required in the 2019 California Building Code. Quantity of receivers shall accommodate a minimum of 4% of the total number of seats as shown on the system drawings, and architectural drawings.

2. Twenty-five percent of the receivers shall include hearing-aid compatible neck loops.

3. Provide a portable system for student(s) to carry to classrooms and connect to classroom AV system designated output.

B. It is the intent of the Drawings and Specifications, which are presented in a "design-build" format, for the Contractor to design, provide and install a complete, fully operational, and tested system.

C. All miscellaneous system components including, but not limited to, cables, termination equipment, punch blocks, patch panels, backboards, cabinets, power strips, mounts, fasteners, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.

D. The Assistive Listening System shall include, but not be limited to, the following subsystems / products:

1. See Products Section.

1.2 RELATED WORK

A. Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions and sections of Divisions 1 and 27 of these specifications.

B. All applicable portions of Section 26 00 00 shall apply to this section as though written herein completely.

1.3 GENERAL REQUIREMENTS

A. The Contractor shall hold a valid State of California C-7 Low-Voltage license, shall have completed at least 5 projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at least five years, and capable of being bonded to assure the Owner of performance and satisfactory service during the guarantee period.

B. The Contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work.

C. All work shall be performed under the supervision of a company accredited by the basic equipment manufacturer and such accreditation must be presented.

D. The installing Contractor shall be a factory authorized distributor and warrantee station for the brand of equipment offered and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment.

E. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. The Contractor shall also furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.

1.4 QUALITY ASSURANCE

A. In order to maintain a high degree of quality assurance, the Contractor shall, without exception, use the parts and supplies as specified on the drawings and in this specification.

B. For any proposed product substitution or when the Contractor intends to include an “or equal” product in the bid pricing, provide a substitution request submittal to the Owner’s Project Manager for review no later than fifteen (15) calendar days prior to Bid submittal. This report shall include:

1. Description of how the proposed product(s) will impact meeting the project completion date, indicate item(s) with lead times and expected delivery date(s).

2. Itemized cost comparisons between the proposed product(s) and the listed product(s).

3. Detailed technical analysis of the electrical and mechanical specification differences between the proposed product(s) and the listed product(s).

4. ETL “Verified” or UL “Verified” test lab documentation for the proposed product(s), component(s) and assemblies.

5. Proposed product identification, manufacturer literature (specifications and cut sheets).

6. Name, address and contact information of several similar projects where the proposed product(s) have been used.

7. Name, address and contact information of the proposed product(s) manufacturer's local representative.

8. Sample proposed product(s) manufacturer's warranty.

C. The Owner's Design Team/Project Manager must approve any proposed product(s) substitution item in writing. The Owner's Design Team/Project Manager reserves the right to require a complete sample of any proposed product(s) and may request a sample tested by an independent testing consultant to prove equality. The decision of the Owner's Design Team/Project Manager regarding equality of proposed product(s) items will be final.

D. It is a mandatory requirement that a single Contractor perform the work described in this specification.

1.5 SUBMITTAL AND MANUAL

A. Comply with all requirements of the General Conditions, Supplementary Conditions and applicable sections of Divisions 1 and 26 of these specifications.

B. Additional requirements of this section are:

1. Within fifteen (15) calendar days after the date of award of the Contract, the Contractor shall submit eight (8) copies of the complete submission to the Architect for review.

2. The submission shall consist of five (5) major sections with each section separated with index tabs. Each page in the submission shall be numbered chronologically and shall be summarized in the index.

3. The first section shall be the "index" which shall include the project title and address, name of the firm submitting the proposal and name of the Architect.

4. The second section shall a list of 5 projects of equal or greater scope, and a list of proposed instrumentation to be used by the Contractor. In addition, provide a written notice guarantying the provision of the requested warranty.

5. The third section shall contain the comparative specification listing, including a complete listing of the characteristics of the equipment to be furnished next to all of the specified equipment's features and functions as stated in the specifications and data sheets.

6. The fourth section shall contain an original factory data sheet for every component in the specifications.

7. The fifth section shall contain a designation schedule for each Structured Cabling System location and complete 1/8" = 1'-0" scale drawing showing system wiring plans.

C. Failure to comply with all of the requirements listed above will result in the rejection of the entire submittal package.

D. The Contractor shall provide two copies of an "Operating and Servicing Manual" for the system. The manuals shall be bound in flexible binders. All data shall be printed material or typewritten. Each manual shall include the following: Instructions necessary for the proper operation and servicing of the system; complete as-built installation drawings of the system; a wiring destination schedule for each circuit leaving for each piece of equipment; a schematic diagram of major components with all transistor and IC complements and replacement number.

1.6 GENERAL SYSTEM PRODUCT WARRANTY

A. Prior to Owner acceptance, the Contractor shall provide to Owner, a manufacturer's product warranty. On behalf of the Owner, the Contractor shall submit the required warranty registration form within ninety (90) days of Contractor's purchase. The Owner will only acknowledge acceptance upon submittal of a valid manufacturer's warranty.

B. The warranty shall commence from the date of final written acceptance by the Owner.

C. All conditions for obtaining the manufacturers warranty shall be the sole responsibility of the Contractor.

D. The manufacturer shall warrant the transmitter and receivers to be free from defects in workmanship and material under normal use and conditions for the useful lifetime of the product from date of purchase. Useful lifetime is defined as five (5) years from date of purchase. All other products and accessories shall have a one (1) year limited warranty to be free from defects in workmanship and material under normal use and conditions from date of purchase.

E. Any material showing mechanical or electrical defects shall be replaced promptly at no expense to the Owner.

F. A typewritten notice shall be posted at the equipment rack(s) that shall indicate the firm, address and telephone number to call when service is necessary. The notice shall be mounted in a neatly finished metal frame with a clear plastic window and securely attached to the inside of the door.

PART 2 - SYSTEM EQUIPMENT SPECIFICATION

2.1 ACCEPTABLE MANUFACTURERS

A. All equipment listed herein will be by Listen Technologies, cabinet by Chatsworth or approved equal.

B. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications and the equipment's technical data sheets.

C. The functions and features specified are vital to the operation of this facility. Therefore, inclusion of a component's manufacturer in the list of acceptable manufacturers does not release the Contractor from strict compliance with the requirements of this specification.

D. All basic electronic equipment (not including cable) specified herein shall be produced by a single manufacturer of established reputation and experience who shall have produced similar apparatus for at least three or more years and who shall be able to refer to similar installations rendering satisfactory service.

2.2 SYSTEM FUNCTIONS AND CAPABILITIES:

A. The FM wireless ALS is for use by the hearing-impaired.

B. The ALS system shall be capable of broadcasting on 57 channels and be frequency agile.

C. The ALS shall have 80 dB SNR or greater, end-to-end.

D. Portable receivers shall be frequency agile and frequency set with a “seek” button and shall incorporate an LCD display that indicates battery status, RF signal strength and channel.

E. Portable receivers shall incorporate a stereo headset jack that allows the user to plug in either to a mono or stereo headset and listen to the audio normally.

F. Portable receivers shall incorporate automatic battery charging circuitry for the recharging of NiMH batteries.

G. Audio signal inputs shall consist of 3.5mm jacks, located in wall or floor boxes as indicated on the plan drawings.

2.3 PRODUCTS:

The following is to be used as a GUIDE, and are to be included, but not limited to, in the system(s) to be supplied.

A. Listen Technologies LT-800 Stationary Transmitter

1. The stationary FM transmitter shall be capable of broadcasting on 57 channels. The transmitter shall have a signal-to-noise ratio (SNR) of 80dB or greater. The output power shall be adjustable to quarter, half or full and channel tuning shall be capable of being locked. The device shall broadcast on both wide and narrow band channels. The device shall have an audio frequency response of 50Hz to 15kHz, ± 3dB at 72MHz, or of 50hz to 10kHz, ± 3dB at 216Mhz. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, mix level, and an adjustable low pass filter. The device shall have an audio processor that is capable of automatic gain control and limiting.

2. Provide quantity of one (1).

B. Listen Technologies LA-122 Universal Antenna Kit

1. The antenna shall work on both 72 MHz and 216 MHz, with a transmission range of up to 1,500 feet (at 72 MHz) and 3,000 feet (at 216 MHz). The antenna shall include multiple options, monopole, dipole, wall or ceiling mounting option, fasteners, mounts, etc. Contractor shall provide coax cable from antenna to the FM transmitter, use RG58 for cable runs less than 100 feet or RG8 for cable runs more than 100 feet (50 Ohm), or as recommended by the manufacturer.

2. Provide quantity of one (1).

C. Listen Technologies LT-700 Portable FM Transmitter

1. The portable FM transmitter shall be capable of broadcasting on 57 channels. The unit shall incorporate a microphone sensitivity switch. The device shall broadcast on both wide and narrow band channels with a SNR of 80dB or greater. The device shall have an audio frequency response of 50Hz to 15kHz (± 3dB) at 72MHz, or of 50Hz to 10kHz, (± 3dB) at 216MHz. The device will incorporate a mute switch and the battery door shall be capable of being mechanically locked. The device shall incorporate an LCD display that indicates channel, battery level, low battery, battery charging, and RF signal strength. The portable transmitter shall incorporate automatic battery charging circuitry for the recharging of NiMH batteries, with the ability to charge via a wall transformer or drop in charging case. Each portable transmitter shall come equipped with its own patch cable allowing them to easily interface with the input of a stationary sound system anywhere on campus. Include one (1) line input cable with each portable transmitter. Listen Technologies part number LT-700-072, LT-700-216.

2. Provide quantity required per 2019 CBC 11b-219 ALS requirements.

D. Listen Technologies LR-4200 Portable Receiver

1. The FM receiver shall be capable of receiving on 57 wide and narrow band channels. The receiver shall tune to a single channel and user shall not be able to change the channel. The receiver shall have a signal-to-noise (SNR) ratio of 80 dB or greater (70dB for the 216MHz models) and shall have an audio frequency response of 50 Hz - 15 kHz (±3 dB). The receiver shall employ a unique DSP SQTM noise reduction technology. The receiver shall have a programmable squelch circuit. The receiver shall incorporate a multi-functional display (OLED) that indicates battery status, inventory number, volume level and customizable channel names. The receiver shall have the option of being lanyard or belt clip worn and the lanyard shall incorporate an integrated neck loop for compatibility with T-coil hearing aids. The receiver shall be intelligent and provide customized audio to either earphones or the integrated neck loop based upon which is connected. The receiver shall have two (2) 3.5 mm (TRRS) connectors to drive the integrated neck loop lanyard or up to two (2) mono or stereo earphones. The receiver shall be fully programmable via supplied software. The receiver shall have a micro USB connector used for programming/setup, inventory control, charging, and firmware upgrades. The receiver shall incorporate automatic battery charging circuitry and use a non-proprietary lithium ion (Li-ion) battery. The receiver shall automatically turn on when removed from the charging device and automatically turn off when returned to the charging device. The receiver shall have additional charging contacts to allow multiply charging options. The receiver shall be covered by a hassle free limited lifetime warranty. Listen Technology part numbers LT-4200-072, LT-4200-216.

2. Provide quantity required per 2019 CBC 11b-219 ALS requirements.

E. Listen Technologies LA-166 Neck Loop (hearing-aid compatible), for wireless connection to hearing aids equipped with a “T” coil. PROVIDE quantity required per 2019 CBC 11b-219.3 ALS requirements.

F. Listen Technologies LA-164 Ear Speaker, over-the-ear design, single ear clip. Provide one (1) ear speaker device for each portable receiver.

G. Listen Technologies LA-311-01, 16-Unit Charging/Carrying case. Case shall have drop-in charging stations for simultaneous charging of up to 16 portable receivers. Case shall have auto shut-off feature to prevent over-charging receivers. Case shall be hard-sided and lockable. Provide quantity as required to charge and store all portable devices.

H. Listen Technologies LA-362 NiMH rechargeable batteries, Provide two (2) batteries for each portable device.

I. Listen Technologies LA-304 Notification signage kit(s), or as directed by Architect. See Architect drawings for quantity. PROVIDE QUANTITY AND LOCATIONS PER 2019 CBC 11B-216.10

J. Chatsworth Products #11900-724 Wall Mount Cabinet. Cabinet shall include a lockable Plexiglas front door. Dimensions shall be 24”x24”x24”. Provide quantity of one (1).

K. Extron 3-channel audio mixer #60-737-01. Mixer shall be able to combine three line level mono audio sources into a single line level mono output. It shall accept balanced or unbalanced input signals, and provide a balanced or unbalanced output. Three input gain controls shall enable adjustment of mix levels from -80dB to +20dB. Provide quantity of one (1).

L. Extron rack mount shelf #60-190-20. Shelf shall be 1 rack-unit high to support the 3-channel mixer. Provide quantity of one (1).

M. Extron #70-1173-01, 3.5mm female jack on white Decora faceplate, or RDL #D-MJPT mini-jack pass-through plate. Faceplate shall include 3.5mm jack (1/8”) for input connections, and mount into a flush wall or floor box. Provide quantity as noted on the plan drawings.

N. Portable Listen Technologies System LS-05-072 / LS-05-216, Personal FM System. System shall include (1) LT-700 portable FM transmitter, (1) LA-261 lavalier microphone, (1) LR-400 portable FM receiver, (1) LA-164 ear speaker, (1) LA-306 soft case, (2) LA-361 high capacity AA alkaline batteries (two sets), and (2) portable chargers. This portable system will be for student to carry to indivudual classes.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's wiring diagrams. Should any variations in these requirements occur, the Contractor shall notify the architect before making any change. It shall be the responsibility of the factory-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.

B. Furnish all conduit, junction boxes, conductors, cables, faceplates, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.

C. The cables within the rack or cabinets shall be carefully wrapped and strapped with Velcro tie straps. Nylon type “zip ties” or tie-raps are prohibited. All cables shall be numbered for identification at both ends. Cable numbering shall be provided on final as-built drawings.

D. The Contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc. The Contractor shall remove all debris and rubbish occasioned by the electronic systems work from

the site. The Contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., caused by the performance of this work.

E. The system must meet all local and other prevailing codes.

F. The system must meet all 2019 CBC code section 11B-219 and 11B-706 Assistive Listening Systems requirements.

G. The system shall accommodate a minimum of 4 percent of the total number of seats in the required area.

H. Contractor shall provide Assistive Listening System signage in the quantities and locations as indicated on the architectural drawings, and as required by 2019 CBC and the 2010 ADA Standards.

I. Prior to ordering equipment, Contractor shall perform a radio frequency (RF) test to determine and identify any potential RF interference. Contractor shall be responsible to select ALS system radio frequencies that do not receive RF interference from other building systems such as lighting, power, generators, HVAC, computers, audio paging, etc. Final system testing shall be conducted with all building systems (lighting, HVAC, etc.) turned on to verify the ALS system is free of any building system interference. If RF interference is detected within the first 30 days after project completion, Contractor shall replace ALS equipment with equipment on another frequency at no additional cost to the Owner. Contractor shall include all costs in base bid.

J. All cabling shall be splice free.

K. Plenum rated cable may be run exposed above ceilings, provided the cabling is supported independent of other utilities such as conduits, pipes, and the ceiling support systems. The cables shall not be laid directly on the ceiling panels. The use of cable ties shall be done in accordance with the cable manufacturer's requirements. The cable jacket composition must meet local and all other prevailing fire and safety codes.

L. All firewalls penetrated by structured cabling shall be sealed by use a non-permanent fire blanket or other method in compliance with the current edition of National Fire Protection Association (NFPA) and the California Electric Code (CEC) or other prevailing code. The Contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. Contractors who use this method will be required to replace all cables affected and provide the original specified access to each effected area.

M. All equipment racks and cabinets shall be installed on painted 3/4” A/C-grade plywood backboard and bolted to the building structure by the Contractor.

N. Install antennas where indicated on plans or as necessary to cover areas required for assistive listening. Coordinate final antenna location(s) in field with Owner or Architect prior to rough-in.

O. The installer shall, upon completion of the system, orient all antennas, adjust all controls, etc., to provide a system operating at maximum capability.

P. Submit block diagram and as-built drawing of all equipment.

Q. 120 Volt AC power for rack/cabinet(s) shall be provided by the Electrical Contractor.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide all instruments for testing and demonstrating in the presence of the Owner's inspector that the frequency response is as stated in the factory data sheets, and that the system covers all areas of the room(s) where intended. Check all circuits and wiring to verify they are free of shorts and grounds.

3.3 FINAL ACCEPTANCE

A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.

B. The Owner or Owner's representative will conduct a final job review once the Contractor has finished the job. This review will take place within one week after the Contractor notifies the Owner.

C. Two (2) copies of all certification data and drawings for all identifications shall be provided to Owner before the Owner's review.

D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.

E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing will be billed back to the Contractor.

F. In the event that repairs or adjustments are necessary, the Contractor shall make these repairs at his own expense. All repairs shall be completed within ten (10) days from the time they are discovered.

G. The Contractor shall provide not less than eight (8) hours for site instruction of personnel in the operation and maintenance of the installed systems. This instruction time shall be divided as directed by the Owner.

H. The Contractor shall hand to the Owner a copy of any applicable installation specific software configurations in compact disk (CD) or USB thumb drive format.

END OF SECTION

SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes furnishing materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of an Electronic Safety and Security systems.

1.02 RELATED WORK

A. General requirements specifically applicable to Division 28 in addition to the provisions of Division 1.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them, including but not limited to the following.
   1. Section 01 Seismic Requirement for Non-Structural Components & Systems.
   2. Division 07 Penetration Fire Stopping.
   3. Division 07 Door Hardware.
   4. Section 27 15 00 Communications Horizontal Cabling.
   5. Section 27 11 00 Communications Equipment Room Fittings.

1.03 REFERENCE

A. The latest published edition of a reference shall be applicable to this Project unless otherwise noted.

B. International Building Code (IBC)

C. American National Standards Institute (ANSI).

D. ANSI/TIA-568 - Commercial Building Telecommunications Cabling Standard.

E. ANSI/TIA TSB-184A – Guidelines for Supporting Power Delivery Over Balanced Twisted Pair Cabling

F. ANSI/TIA-569 - Telecommunications Pathways and Space Standard

G. ANSI/TIA-606 - Administrative Standard for Commercial Telecommunications Infrastructure.

H. ANSI/TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises Standard.

I. ANSI/TIA-862 Building Automation Systems Cabling Standard.

J. ANSI/TIA 942 - Telecommunications Infrastructure Standard for Data Centers.

K. ANSI/TIA 1152 Field Testing of Twisted Pair Communication Cables.

L. ANSI/TIA-5017 – Telecommunication Physical Network Security Standard.

M. T-758 Outside Plant

N. T-862 Intelligent Building

O. T-942 Data Center

P. T-1179 Healthcare

Q. T-4966 Education

R. T5017 Telecommunication Physical Network Security

S. ANSI/Building Industry Consulting Service International (BICSI) - Telecommunications Distribution Methods Manual (TDMM).

T. ANSI/BICSI - Electronic Safety and Security Design Reference Manual (ESSDRM).

U. ANSI/BICSI-N2-17 - Practices for the Installation of Telecommunication and ICT Cabling Intended to Support Remote Power Applications.

V. National Fire Protection Association (NFPA) Article 70, Article 78.

W. National Electrical Code National (NEC).

X. California Title 24 Electrical Code.

Y. National Electrical Safety Code (NESC).

Z. Federal Communications Commission (FCC).

AA. Underwriter's Laboratories (UL).

BB. UL 294 (Underwriters Laboratories) - Access Control System Units.

CC. National Defense Authorization Act (NDAA) Section 889.

DD. Federal Information Processing Standards (FIPS).

EE. Local fire code, building code, mechanical code, electrical code, rules and interpretations required by the authority having jurisdiction (AHJ).

FF. The referenced codes establish a minimum level of requirements. Follow the more stringent provision of the codes where there is a conflict between codes. Follow any code where there is a conflict between the code and the requirements of the Specifications. Compliance with code requirements shall not relieve the Contractor from complying with the requirements of the Specifications and the Drawings

1.04 WORK OF OTHER TRADES

A. The Drawings do not show complete details of the building construction. Refer to the architectural, structural, civil, fire protection, mechanical, electrical, security, audiovisual, mill work and reflected ceiling Drawings for those details which may affect the execution of this Work.

B. Coordination: Conform to the requirements of Division 01. Failure to coordinate Work will be considered sufficient cause for Work to be altered at Contractor's expense, as directed by Architect.
1. Plan and execute Work including, but not limited to conduits, back boxes enclosures and speakers in cooperation with other trades.
2. Notify other trades of any Work affecting their Work to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeves, firestopping, painting, finishing, or other matters which will cause delays or necessitate work-around methods.

1.05 EXISTING CONDITIONS

A. Visit the site prior to bidding to become familiar with existing conditions and other factors which may affect the execution of the Work.

B. Visit the site to verify demolition Work. Coordinate with the Owner prior to commencement of Work. Maintain service to existing equipment and devices to be retained in area adjacent to the existing areas scheduled for renovation.

C. Protect the installation of and the integrity of existing systems, devices and cables during demolition Work.

D. Protect existing buildings and spaces from water and dust seepage into the existing buildings and spaces.

1.06 CODES, PERMITS, INSPECTIONS, AND FEES

A. Conform to requirements of Division 01, [Section [01 41 00]].

B. Obtain permits and inspections and pay fees required by National, State and Local authorities. Make arrangements for inspections by the Architect, Owner or other authority as required. Submit 3 copies of certificates of compliance to the Architect.

C. Work and materials shall be in accordance with requirements of the latest adopted edition of applicable codes, regulations, ordinances, and local amendments.

D. Remove Work that is not in compliance with the codes, ordinances, or regulations.

E. Where Drawings or Specifications call for material or construction of a better quality or larger sizes than required by the above-mentioned rules and regulations, the provisions of the Drawings or Specifications shall take precedence over requirements of the rules and regulations.

F. Coordinate with the appropriate “Authorities Having Jurisdiction” for this Project.
1. Arrange plans and shop drawing reviews.
2. Schedule inspections.
3. Notify the Architect of non-conformance issues.
4. Proceed with changes suggested by the authorities having jurisdiction only with written authorization by the Architect.
5. Make necessary corrections as required by the authorities having jurisdiction.

1.07 SAFETY

A. Coordinate job site safety requirements with the Architect and Owner. Provide safety measures continuously during work.

B. Provide safety policies, training, retraining, equipment, safeguards, restraints, permit systems, and other safety measures required by federal, state, local, and the Owner’s site rules and regulations and for the safe performance of the Work.

C. Comply with the “Safety and Health Regulations for Construction,” 29 CFR 1926, by the U.S. Department of Labor.

D. Consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether the Contractor is or is not in compliance with state or federal regulations.

E. Notify the Architect and Owner of any unsafe conditions observed or experienced.

F. Perform safety audits, inspections, meetings, and personnel interviews in accordance with federal, state, local, and Owner site safety rules and regulations.

G. Do not use the Architect’s construction observations as a substitute for Contractor’s safety audits and inspection responsibilities

1.08 SUBSTITUTIONS

A. Conform to requirements of Division 01, [Section [01 25 00]].

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Include, in each request for substitution, the following.
   1. Product identification, manufacturer's name and address.
   2. Product Data: Description, performance and test data, reference standards, finishes, and colors.
   3. Samples: Finishes.
   4. Complete and accurate drawings indicating construction revisions required to accommodate substitutions.
   5. Data relating to changes required in construction schedule.
   6. Cost comparison between specified and proposed substitution.

D. When approved substitute equipment or material necessitates revisions to the Drawings or involves other trades, include drawings and details showing such changes, and coordinate and assume any liability from the affected trades.

E. Acceptance: The acceptance of a manufacturer's name or product by the Architect does not relieve the Contractor of the responsibility for providing materials and equipment which comply in detail with the requirements of the Contract Documents.

F. The Contractor shall be liable for costs incurred by the Owner, Architect, and Engineer for professional services resulting from substitutions.

G. Substitutions will not be considered when they are indicated or implied on Shop Drawings or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

H. The Owner will be the final judge of acceptability, with review by Owner, and the distribution of the acceptance by the Architect. No substitute shall be ordered, installed or utilized without the Architect's prior written verification of acceptance from the Owner

1.09 SEISMIC PERFORMANCE:

A. Rack, ceiling and wall mounted equipment and devices and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.10 SUBMITTALS

A. Conform to requirements of Division 01, [Section [01 33 00]].

B. Refer to individual Division 28 Specification Sections for additional requirements for submittals.

C. Submit information that is specific to this Project. Do not submit generic information. Highlight with yellow or blue marker adequate information to demonstrate materials being submitted fully comply with Contract Documents.

D. Do not use the submittal process to request substitutions. Make requests for substitution in accordance with Division 01, [Section [01 25 00]].

E. Product Data: Submit for approval manufacturer's descriptive product information including catalog cuts and other information required to confirm compliance with the Drawings and Specifications, including size, dimensions, model number, electrical characteristics, support requirements, connection requirements and all applicable information verifying that submitted components comply with Contract Documents.

F. Shop Drawings: Submit for approval shop drawings including floor plans with devices identified, wall and rack elevations, sections, schedules, wiring diagrams, schematics, seismic installation instructions, mounting details and other information required to confirm compliance with the Drawings and Specifications.

G. Schedule: Submit for approval a detailed schedule of the installation, testing and hand off to Owner of the Work.

H. Network Connections: Submit for approval a list of devices that will connect to the Owner's wired or wireless networked including the MAC address of the device, the location to be installed and the port configuration needed for connectivity.

I. Samples: Submit for approval samples to the Architect for color and material selection where the color or material selection is not specified.

1.11 SEISMIC PERFORMANCE:

A. Seismic Design: Submit calculations, details, Shop Drawings, Product Data, and statement of special inspections for the seismic design of nonstructural components, in Division 28 to Architect for Architect's review. After Architect's review, Architect will submit the Architect's notification with the calculations, details, Shop Drawings, and statement of special inspections to the Building Official per California Building Code section 107.3.4.1. Do not start Work until the calculations, details, Shop Drawings, Product Data, and statement of special inspections have been approved by the Building Official. If the Contractor hired professional engineer licensed in the State of California determines that the IBC does not require some of the nonstructural equipment to be seismically restrained, then submit a stamped and signed statement from the professional engineer to that effect.
   1. Submit a written "Contractor's Statement of Responsibility", where such statement is required by Section 1704.4 of the California Building Code, to Architect and to Building Official for electrical nonstructural components listed in the statement of

special inspections per California Building Code prior to the commencement of Work on the system or component.

B. Submit seismic certification of electrical nonstructural components and designated seismic systems where such certification is required by Section 1705.13 of the California Building Code.

C. Wind Restraints: Submit calculations, details, Shop Drawings, and Product Data for the wind design of components located outside. After Architect's review, Architect will submit the Architect's notification with the calculations, details, and Shop Drawings to the Building Official per CBC section 107.3.4.1. No Work shall be started until the calculations, details, Shop Drawings, and Product Data have been approved by the Building Official.

1.12 QUALITY ASSURANCE

A. Conform to requirements of Division 01, [Section [01 43 00]].

B. Materials and equipment installed under this Contract shall be new, unused, free of defects, and of current manufacture. Equipment and materials shall carry Underwriters Laboratory certification if required by local, state or national codes.

C. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equivalent" is stated or a substitution is requested, equipment shall be

equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the Owner or Architect.

1.13 QUALIFICATIONS

A. Conform to requirements of Division 01, [Section [01 43 13].

B. Manufacturer: Company specializing in manufacturing products specified in this Division with minimum five years documented experience.

C. Contractor:
1. Specializes in the installing of products specified in this Division with minimum 3 years documented experience, and with service facilities within 100 miles of this Project.
2. Have factory certified technicians to work on any system software and programming of any devices installed on this Project.
3. Are familiar with local codes and contract conditions pertaining to this Project.
4. Have been distributing and/or installing the specific brand and model line of system equipment for at least 3 years prior to the date on the Contract Documents.
5. Have in-house engineering and project management capabilities consistent with the requirements of the Work.
6. Have a project manager and field supervisor in place which oversees the entire Project until completion of the Project including coordination, scheduling, staffing, functional performance testing for this Project.
7. Have a service facility and organization with staffing capable of providing comprehensive maintenance and service to the specified systems within 4 hours after being called, 24 hours per day and 7 days a week.

D. Testing Agency: Company specializing in testing products specified in this Section with minimum 3 years documented experience.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Conform to requirements of Division 01, [Section [01 60 00]].

B. Deliver materials (except bulk materials) in manufacturer's unopened containers, fully identified with the manufacturer's name, trade name, type, class, grade, size and color.

C. Store materials suitably sheltered from the elements, but readily accessible for inspection until installed. Store items subject to moisture damage in dry spaces. Coordinate requirement for storage space with Owner and identify where they will be located in submittals.

1.15 AMBIENT CONDITIONS

A. Conform to requirements of Division 01, [Section [01 89 00]].

B. Assemble equipment and materials off-site whenever possible.

C. Install materials and equipment after the following.
   1. Spaces are enclosed and weather tight.
   2. Wet work in spaces is complete and dry.
   3. Movement of trades and the installation of other materials and equipment will not damage Work.
   4. The installation of materials and equipment in ceiling areas above Work is complete.

D. Remove debris, packaging and waste materials for recycling and disposal from the job site each day.

1.16 PROJECT MANAGEMENT AND COORDINATION

A. Conform to requirements of Division 01, [Section [01 31 00]].

B. Refer to the Work of the Divisions 07, 26 and 27 Sections for location of devices, cables and connections that will interface with Division 28 Work.

C. Refer to the Architectural Drawings for the exact height and location of all back boxes and equipment.

D. Refer to the reflected ceiling plan Drawings for the ceiling construction and height information and for the location of all back boxes and equipment.

E. Identify Work affecting other trades to prevent conflicts or interference as to space requirements, dimensions, openings, block-outs, sleeves or other matters which will cause delays or necessitate work-around solutions.

F. Check space requirements and the physical confines of the area of work to ensure that all material and equipment can be installed in the spaces allotted thereto, including conduits and cable supports.

G. Due to the type of installation, a fixed sequence of operation is required to properly install the complete systems. Coordinate Project and schedule Work in accordance with the construction sequence. Maintain project schedules.

H. Attend all construction meetings, at the Project site or other location, as requested by the Owner or Architect.

I. The Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper compliance with the design intent.

J. Room numbers as shown on Contract Documents may not be the final room numbers. Final room numbers will be provided during construction. Use final room number for labeling and programming of cables and devices that references room numbers.

1.17 RECORD DRAWINGS

A. Conform to requirements of Division 01, [Section [01 78 39]].

B. Project Record Documents: Provide.
1. Plan Drawings and room elevations Drawings showing actual locations and sizes of Work.
2. Approved modifications to equipment in the field shall be shown on the record drawings to reflect the “as-built” conditions.
3. Record drawings shall be consistent. Changes made to plans, elevations, sections, wiring diagrams, schematics, or functional diagrams shall be made to related or otherwise affected plans, elevations, sections, wiring diagrams, schematics, or functional diagrams.

1.18 CLOSEOUT SUBMITTALS

A. Conform to requirements of Division 01, [Section [01 78 23]].

B. [Format for Operating and Maintenance Manuals:
1. Compile product data and related information appropriate for Owner’s maintenance and operation. Prepare data in instructional manual form for use by Owner’s personnel. Modify data as required to accurately represent completed installations.
2. Binders: Commercial quality, 3-hole punched, vinyl covered hardboard binder, secured with aluminum screw posts, sized for 8-1/2 inch by 11 inch sheet format. Do not exceed 3-1/2 inch binder width.
3. Binder Cover: Identify each Manual with printed title, “OPERATING AND MAINTENANCE INSTRUCTIONS”, Project Title, identification of subject matter contained in manual, and completion date of Project. Include names of Owner, Architect, Contractor, and major equipment suppliers.
4. Binder Edge: The binder edge shall be imprinted with the name of the job, Owner, and completion date of Project.
5. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.
6. Text: Manufacturer’s printed data, or neatly typewritten information on 20 pound white or off-white paper.
7. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

C. Contents of Manuals:
1. Project Directory: Indicate Project title and Project number. List Owner, Architect, and Contractor with addresses, telephone numbers, and name of responsible parties.

2. Product Directory: List names, addresses, and telephone numbers of subcontractors and suppliers. Included local sources of supplies and replacement parts. Provide information for re-ordering custom manufactured products.
3. Product Data: Submit product literature. Mark each sheet to clearly identify specific products, models numbers, components parts, and data applied to installation. Delete inapplicable information by marking out, striking out, or by notation.
4. Installation Instructions: Include instructions for installing equipment, devices, and systems. Instructions shall be specific to the installation and shall include pre-installation preparation, installation, and post-installation setup instructions.
5. Drawings and Diagrams: Include supplementing Product Data. Illustrate relations or components parts or equipment and systems. Show wiring, control, and flow diagrams. Do not use Project Record Documents as maintenance drawings.
6. Written Text: Include as necessary to supplement Product Data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
7. Provide information sheet for Owner's personnel indicating proper procedures in event of failure. Include instances which may affect validity of warranties.
8. Each Item of Equipment and Each System: Include description of system, and component parts. Include complete nomenclature and model number of replaceable parts. Identify the following.
    a. Normal functions.
    b. Normal operating characteristics.
    c. Limiting conditions.
9. Operating Procedures: Provide manufacturer's printed operation and maintenance instructions.
10. Maintenance Requirements: Include routine procedures and guide for preventive maintenance and troubleshooting; disassembling, repair, and reassemble instructions; and adjusting and checking instructions.
11. All warranty information shall include the following.
    a. Contractor/labor warranty (to include names and phone numbers).
    b. Parts/system/equipment specific warranties (to include complete list of components).]

1.19 WARRANTY

A. Refer to Division 01 for requirements for Warranties.

B. Provide originals of manufacturers' warranties to the Owner for Owner's records.

C. Register devices, components and systems with the manufacturer.

D. Provide a manufacturer's warranty for all work and all items of equipment and materials for a minimum period of one year, from the date of acceptance of the work, to cover for labor and material. Where a manufacturer's warranty is longer than one year, provide the extended warranty. Notify the Owner and Architect of any defective items. Repair or

replace such items within 24 hours without cost to the Owner, all to the satisfaction of the Owner and Architect. If the failure exceeds 48 hours, the Owner reserves the right to require the Contractor to provide on-site manufacturer support at no additional cost to Owner.

1.20 TRAINING FOR OWNER'S PERSONNEL

A. Refer to Division 01 for additional requirements for training for Owner's personnel.

B. Refer to individual Division 28 sections for additional requirements for training for Owner's personnel for specific systems.

C. Provide for approval a schedule of all Division 28 system training sessions prior to the commencement of training.

D. Provide qualified manufacturer trainers or qualified trainers certified by the manufacturers prior to the commencement of training.

E. Provide for approval qualifications for all Division 28 system trainers prior to the commencement of training.

F. Provide training materials for all training attendees.

G. General Description of Instruction Periods: Each period shall include preliminary discussion and presentation of information from operation and maintenance manuals with appropriate references to drawings, followed by tours of equipment spaces explaining maintenance requirements, access methods, servicing, and maintenance procedures, temperature settings, and available system and equipment adjustments.

PART 2 - PRODUCTS

2.01 GENERAL

A. Subject to compliance with requirements, provide products by one of the manufacturers specified herein. Provide materials and equipment with performance levels and capacities as noted herein.

B. Part numbers provided in this Specification have been coordinated with the manufacturers' latest available product literature. Part numbers are subject to change without notice by the manufacturers. Where a specific part number is invalid, coordinate for approval products meeting component description.

C. Where specific items are called out in the Specification or indicated on the Drawings for a specific application, use those products or materials, or approved substitutes. Where no specific call outs are made, provide premium products and materials. All materials and equipment installed shall have been tested and listed by Underwriters Laboratories

or other approved testing organization and shall be so labeled unless otherwise permitted by the authority having jurisdiction (Inspector).

D. All materials to be new, free from defects and not less than quality herein specified. Materials shall be designated to ensure satisfactory operation and operational life in the environmental conditions which will prevail where they are being installed.

E. Each type of materials furnished shall be of the same make, be standard products of manufacturers regularly engaged in production of such materials and be the manufacturer's latest standard design.

2.02 EXAMINATION OF DOCUMENTS

A. Before submitting a bid, visit the Project Site and become familiar with conditions which may be pertinent to, or affect the cost of, the electrical installation.

B. Become acquainted with the Work of other installers whose activities will adjoin or be affected by the electrical Work. Consult with these other installers and study all pertinent Drawings in order to coordinate the Work and to avoid conflicts, omissions and delays.

C. Before submitting a bid, examine all pertinent Contract Documents for electrical requirements which are not necessarily indicated on the electrical Drawings and include in the bid a sum which is sufficient to cover the costs of these other requirements.

D. Should it be perceived that the Contract Documents do not sufficiently define the required electrical work, contact the Architect for clarification or further description. Failure to do this will be construed as evidence of an understanding of the required electrical systems and their installation.

2.03 PERMITS AND FEES

A. Contractor shall be responsible for obtaining and paying for all necessary electrical permits and fees.

B. The following section should be deleted if project is new construction.

2.04 EXISTING FACILITIES

A. Examine the drawings and specifications of the completed work and inspect the site to establish the scope of demolition work and new work to be provided under this sections and clarification of the phasing of the work.

B. Based on project phasing and scheduling, demolition work will be taking place in and around existing areas that are to remain in service. Where the work under this section affects or interferes with the operation of any existing areas to remain in service, or portions of the work already in operation, provide all necessary work and material including premium pay, required to avoid shutdown of these areas during normal

operations. Obtain Owner's approval for shutdown, in writing, 48 hours prior to shut down.

PART 3 - EXECUTION

3.01 GENERAL

A. Follow manufacturers' instructions for installing materials and equipment and adjusting equipment and cables. Where no instructions are included with the equipment, call manufacturer to obtain detailed instructions, document instructions, and follow those instructions.

B. Sequence, coordinate, install and integrate the various elements of these Specifications and Drawings.

C. Install equipment level and plumb.

D. Verify field conditions and dimensions in the field prior to commencement of Work. Do not block access or service clearance on equipment of these or of the Specifications of other Divisions.

E. Keep all items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures throughout the life of the Project.

F. Protect all materials and equipment from damage, at all times during the construction. Do not install materials and equipment in the telecommunications areas until the other trades have completed their Work in the areas so that the equipment will not be stepped on, moved, or damaged.

G. Provide and maintain safe ingress and egress from Work areas.

H. Deliver to Owner sets of specialty tools specifically needed for proper operation, adjustment and maintenance of cable and cable termination hardware installed under this Contract.

I. Attend Project meetings as scheduled by the Owner.

3.02 DRAWINGS

A. For purposes of clarity and legibility, the Technology Drawings are essentially diagrammatic. although the size and location of Technology equipment is drawn to scale wherever possible, make use of all data in all the Contract Documents, and verify this at

the Project Site. Determine the exact location of conduits, outlets and equipment by the study of details, shop drawings and/or the Architect's directions.

B. The Technology Drawings show the required size and points of termination of the conduits and the quantity and size of the conductors within. However, the Drawings do not show all the necessary conduit routing. Install conduits in such a manner as to conform to structure, avoid obstruction, preserve headroom and keep passageways and openings clear.

C. Locate outlets symmetrically with architectural elements, notwithstanding the fact that the locations shown of the electrical drawings may be distorted for clarity of representation.

D. The architectural Drawings take precedence over the electrical Drawings. Refer to the reflected ceiling plans and interior elevations to determine the exact location of lighting fixtures, wall-mounted devices and fixtures, etc. The Architect has taken a very active role in the placement of these items. Should there be a conflict between locations shown on the architectural and electrical drawings, contact the Engineer for clarification prior to rough-in.

3.03 VERIFICATION OF AVAILABLE SPACE

A. Throughout the course of construction, verify that sufficient space will be available for the equipment their required clearances to be installed. If conflict determined, contractor shall contact the design team for clarification on how to proceed.

3.04 EXISTING FACILITIES

A. Based on project phasing and scheduling, demolition work will be taking place in and around existing areas that are to remain in service. Where the work under this section affects or interferes with the operation of any existing areas to remain in service, or portions of the work already in operation, provide all necessary work and material including premium pay, required to avoid shutdown of these areas during normal operations. Obtain Owner's approval for shutdown, in writing, 48 hours prior to shut down.

B. Existing electrical and signal facilities outside of the demolition area to remain in place and in service during demolition.

C. Where areas of existing facilities are indicated to be demolished or remodeled, relocate electric and signal system equipment, and reroute or replace conduit and wiring as required to conform with new use of the area and maintain operation of adjacent areas.

D. Unless specifically noted or otherwise indicated or directed, remove all existing electrical equipment in the areas to be demolished. Deliver all equipment removed, including lighting fixtures, to the Owner's representative

E. Where remodeling of existing areas is indicated, provide all work indicated and required for a complete and operating facility. Where work is adjacent to existing fixtures or devices, provide matching products to present uniform appearance. Salvage demolished material and equipment and deliver to Owner as directed. Dispose of salvaged materials and equipment where so directed in writing by Owner. Patch all openings in existing walls or floors caused by removal of materials and/or equipment under this work.

3.05 WATERPROOFING

A. Wherever electrical Work pierces waterproofing or waterproofing membranes, install it in an approved watertight manner.

3.06 INSTALLATION

A. Comply with BICSI TDMM, and the TIA -568, TIA -569, TIA -606, and TIA 607-A standards.

B. Comply with applicable federal, state and local requirements, codes and ordinances of authorities having jurisdiction.

C. Comply with manufacturers' specifications, installation manuals, and published recommendations and best practices.

3.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials and equipment according to the manufacturer's recommendations, using means and methods that shall prevent damage, deterioration, and loss, including theft. Handle equipment carefully to prevent damage, breakage, denting, and scoring of finishes. Replace damaged equipment.

B. Store products subject to damage by the elements above ground, undercover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

3.08 CUTTING AND PATCHING

A. Provide core drilling, cutting and patching of existing construction and surfaces for the installation of electrical systems. Concrete, asphalt or plaster surfaces which have been damaged by such drilling or cutting shall be patched and repaired to match the surrounding surface.

3.09 ADJUST AND CLEAN

A. Keep the Project Site free from accumulations of electrical rubbish and debris. Remove such accumulations from the Project Site.

B. Thoroughly clean electrical equipment and materials of plaster, cement and other foreign materials and leave smooth, clean and dry.

3.10 CYBERSECURITY PROTECTION

A. For installed systems that have internet connectivity, including but not limited to controls, monitoring, metering, sensors, or other remote access capabilities, the General Contractor is responsible to request from its subcontractors a cybersecurity risk mitigation plan. All cybersecurity risk mitigation plans shall be coordinated with the owner to verify functionality and compatibility with the owner's network architecture and topology. Cybersecurity risks to be mitigated include intrusion, remote access, viruses, spy-ware, and malware. Put in-place and in-use effective protection and homogenous policies for infrastructure, servers, workstations, controllers, network connected equipment, internet connected systems/devices, Wi-Fi devices, IOT devices and mobile devices. Where relevant and applicable, apply the requirements of ISO/IEC 27000 Series of Standards relating to "Information Technology - Security Techniques".

B. For "highly secure environments" identified by the Owner, implement relevant jurisdiction-specific standards to be performed by an accredited Information Security advisor

3.11 INSTALLATION

A. Comply with BICSI TDMM, BICSI ESSDRM and the TIA/EIA-569, TIA/EIA-606, and TIA/EIA 607-A standards.

B. Comply with applicable federal, state and local requirements, codes and ordinances of authorities having jurisdiction.

C. Comply with manufacturers' specifications, installation manuals, and published recommendations and best practices.

3.12 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials and equipment according to the manufacturer's recommendations, using means and methods that shall prevent damage, deterioration, and loss, including theft. Handle equipment carefully to prevent damage, breakage, denting, and scoring of finishes. Replace damaged equipment.

B. Store products subject to damage by the elements above ground, undercover in a weather tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

3.13 CONSTRUCTION ADMINISTRATION

A. Substitutions
1. Refer to other Sections of these Specifications for substitution requirements.

B. Submittals
   1. All submittals shall be provided in electronic format for review.
   2. All submittals associated within a single specification section shall be submitted as a single package. Piecemeal submittals will be rejected as incomplete.
   3. Re-submittals shall only include the requested resubmittal documentation. A complete resubmittal including approved equipment and materials will be rejected.
   4. If an error in the submittals is not detected during the review process, this does not grant the contractor permission to proceed in error. Regardless of any information contained in the submittals, the requirements of the drawings and specifications must be followed and are not waived or superseded by the submittal review. Any conflicting information shall be brought to the attention of the engineer and design team through the RFI process.

C. Requests for Information (RFIs)
   1. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 1).
      a. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
      b. RFIs shall address single questions and related issues only.
      c. All RFIs shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to Owner’s Design Representative.
   2. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
      a. Project name.
      b. Project number.
      c. Date.
      d. Name of Contractor.
      e. Name of Architect and Construction Manager.
      f. RFI number, numbered sequentially and unique.
      g. RFI subject.
      h. Specification Section number and title and related paragraphs, as appropriate.
      i. Drawing number and detail references, as appropriate.
      j. Field dimensions and conditions, as appropriate.
      k. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
      l. Contractor's signature.
      m. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
      n. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

3. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response for each RFI, plus additional time for Architect and General Contractor to review and forward. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.
   a. The following Contractor-generated RFIs will be returned without action:
   b. Incomplete RFIs or inaccurately prepared RFIs.
   c. RFIs submitted without indication of review and approval for submission by General Contractor.
   d. RFIs addressing multiple unrelated issues.
   e. Requests for approval of submittals.
   f. Requests for approval of substitutions.
   g. Requests for approval of Contractor's means and methods.
   h. Requests for information already indicated in the Contract Documents.
   i. Requests for adjustments in the Contract Time or the Contract Sum.
   j. Requests for interpretation of Engineer's actions on submittals.
   k. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

D. Installation Drawings
   1. Prepare dimensionally accurate floor plans of each electrical and signal room and/or closet, fire control room and the like, drawn to 1/4" scale minimum. Submit electronic copies for review with two prints for Architect's record. Indicate all equipment within the rooms to scale based on shop drawing data, include structural support for suspended equipment and description of seismic bracing and fastening. Indicate system and equipment grounding details as applicable. Review elevator machine room shop drawings and coordinate location of electrical gear to maintain clearances. Submit with shop drawings.
   2. Where conduit runs, 2" trade size and larger, are run in exposed locations, prepare dimensionally accurate floor plans indicating routing, coordinated with work of other trades and the structure. Submit legible reproducible transparencies with two prints for review.

E. Project Record Documents
   1. Maintain Record Documents which clearly indicate variances from the specified systems, and which accurately locate all underground electrical conduits and structures.

3.14 SEISMIC AND WIND RESTRAINTS

A. Seismic Restraints: Seismically restrain equipment, pull boxes, cable tray and conduit in accordance with the requirements of the California Building Code. Design of seismic

restraints shall allow for the stress and thermal expansion of cable tray and conduit. Nonstructural components in Division 28 shall be as defined by ASCE 7.

1. Obtain the services of a professional engineer licensed in the State of California to prepare the seismic design for nonstructural components. The professional engineer licensed in the State of California shall also prepare a statement of special inspections per requirements of the California Building Code where such statement is required by Code. Submit calculations, details, Shop Drawings, Product Data, and statement of special inspections for the seismic design of equipment, pull boxes, cable tray and conduit. If the professional engineer determines that the California Building Code do not require some of the nonstructural components be seismically restrained, then submit a stamped and signed statement from the professional engineer to that effect.
2. Seismic Certification of Nonstructural Components: Submit manufacturer's certification by analysis, testing, or experience for nonstructural components and designated seismic systems in accordance with Section 13.2 of ASCE 7, where such certification is required by Section 1705.13 of the California Building Code.

B. Wind Restraints: Restrain components located outside in accordance with the wind requirements of the California Building Code.
   1. Obtain the services of a professional engineer licensed in the State of California to prepare wind restraint design for electrical equipment located outside. Submit calculations, details, Shop Drawings, and Product Data for wind restraints for electrical equipment.

C. The professional engineer obtained by the Contractor shall prepare both seismic and wind designs

3.15 FIRESTOPPING

A. Provide fire-stopping materials to penetrations of fire or smoke rated floor and wall assemblies to maintain fire-resistance rating of the associated assembly in accordance with Division 07 requirements.

B. Apply materials as part of an approved UL Certified Firestop system.

C. Apply materials in environmental conditions (temperature, humidity. vibration and cleanliness) acceptable to the Manufacturer of the firestop system.

D. Refer other Division 27 Specifications for the installation requirements for cables.

E. Provide labels at fire-stopped locations which indicate the UL system, material manufacturer and lot number, code and serial number.

3.16 CLEAN UP

A. Continually remove debris, cuttings, crates, cartons, etc., created by Work. Clean daily and at enough frequency to eliminate hazard to public, other workmen, the building or Owner staff.

B. Perform final cleaning including the following.
   1. Carefully clean cabinets, wiring devices, cover plates, etc. to remove dirt, dust, lubricant, cuttings, paint, plaster, mortar, concrete, etc.
   2. Touch-up scratched or damaged finished surfaces to match factory finish.

END OF SECTION

SECTION 28 13 00 - CREDENTIALED ACCESS CONTROL MANAGEMENT SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes furnishing materials, equipment, labor, supervision, tools, software, licenses, and items necessary for the design, construction, installation, connection, programming, integration, testing and operation of a credentialed access control management system.

B. The Work under this Section includes working in buildings during hours where staff, students, conduct business and travel between building, floors, and areas.

C. Owner provided-owner installed items under this section.]
1. Application servers.
2. Workstations.
3. Badging stations.

1.02 SYSTEM DESCRIPTION

A. This section includes but is not limited to the following equipment and the associated installation thereof:
1. Control panel.
2. Power supplies.
3. Enclosures.
4. Card readers.
5. Card reader/keypads.
6. Door Detectives.
7. Magnetic door contact sensors.
8. Request-to-exit devices.
9. Strobe lights.
10. Cable.
11. Uninterruptable power supply/battery system.
12. Conduit.
13. Backboxes.
14. System programming.
15. Testing.
16. Final adjustment.
17. Documentation.

B. The Owner is currently using the following.
1. A credentialed access control management system by Verkada Allegiance.
2. A video management system by Verkada Allegiance.

C. The system shall be expanded as identified to accommodate new access management system, video management system, intrusion detection management and Intercom system devices.

D. The software and licensing is to be provided by the owner and installed by the contractor.

1.03 RELATED DOCUMENTS

A. Division 07 Firestopping.

B. Division 08 Doors.

C. Division 08 Door Locking Hardware.

D. Division 08 Door Operator Hardware.

E. Division 11 Parking Control Equipment.

F. Division 14 Elevators.

G. Division 14 Elevator Control System.

H. Division 27 Communication Equipment Room Fittings.

I. Division 28 Video Management System.

J. Division 28 Video Surveillance Cameras.

K. Division 28 Intrusion Detection Management System.

L. Division 28 Infant Protection System.

M. Division 28 Fire Alarm System.

N. Division 32 Metal Fences and Gates

1.04 CODES AND STANDARDS

A. Federal Information Processing Standards (FIPS):
   1. Advanced Encryption Standard (AES) (FIPS 197).
   2. FIPS 201: Personal Identity Verification (PIV) of Federal Employees and Contractors.

B. Homeland Security Presidential Directive 12 (HSPD-12).

C. Underwriters Laboratories (UL):
   1. UL294 - Access Control System Units.

2. UL1076 - Proprietary Burglar Alarm Units and Systems.

D. Underwriters' Laboratories, Inc. Listed for meeting the requirements of UL-294, "Standards for Access Control System Control Units".

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 ACTION SUBMITTALS

A. Qualifications:
1. Resumes and certifications of technicians and project managers who will support the installation.

B. Manufacturer’s Instructions:
1. Application conditions and limitations of use stipulated by the manufacturer.
2. Manufacturer’s instructions for storage, handling, protection, examination, preparation, operation, and installation of product.

C. Product Data:
1. System data.
2. Materials list.
3. Technical data (cut sheets) for on each component, including finishes and weights
4. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

D. Calculations.

E. Shop Drawings:
1. Description of system operation
2. Equipment design considerations for future expansion.
3. Coordinated floor plans showing devices with their point numbers and all terminal-to-terminal wiring.
4. Coordinated reflected ceiling plans showing devices with their point numbers and all terminal-to-terminal wiring. .
5. Coordinated site drawings for areas with parking and pedestrian control gates showing devices with their point numbers and all terminal-to-terminal wiring.
6. Cable diagrams for power, signal and control cables showing interface circuits for each piece of equipment, termination, and connection, including wire numbers.
7. Conduit and back box schedules
8. Power requirements.
9. Battery and charger calculations for power supplies, controllers, and input/output modules.
10. Details of seismic strengthening of components and enclosures.
11. Sequence of operation.
12. Device schedules.

13. Detailed system head end layouts (plan and elevations) for components, enclosures and power supplies installed in the communication rooms.
14. Server requirements.
15. Sequence of operation.
16. Network diagrams.
17. Recessed Mounted Card Reader. Provide card reader cut out size and mounting information to the appropriate subcontractor.

F. Deferred Submittals:
1. Network connection requirements.
2. Network address requirements.
3. Manufacture’s system installation instructions and programming templates.
4. System test plan and schedule.
5. System training plan and schedule
6. Documentation:
7. License description.
8. License list, including quantities provided and duration of authorization.

G. Certifications:
1. Certificates of training by the Manufacturer for technicians assigned and working on the Project.

H. Schedule of Values:
1. A schedule of values for furnished and installed unit costs for each basic and optional system component and software component. The schedule of values shall include hardware components, software components, component part numbers, component quantities, and furnish & install unit prices.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Provide in accordance with Section 28 05 00 - Common Work Results for Electronic Safety and Security Systems.
1. Project record Documents
2. Record actual and factual location of system components including conduit and cabling.
3. Product data.
4. Floor plans identifying devices, devices IDs, raceway routing and signage locations.
5. Cable diagrams for power, signal and control cables showing interface circuits for each piece of equipment, termination, and connection, including wire numbers.
6. Conduits, pull boxes and cable routing shown on enlarged door plans and floor plans.
7. Cable termination schedules for cables and components.

8. System and component programming manual/sheets.
9. Test procedures and results.
10. Certificate of acceptance testing.
11. Labeled keys to enclosures and cabinets.
12. Spare fuses.
13. Tools for tamper-resistant enclosures.
14. Tools for manual resetting devices.

B. Test procedures and results.

C. Certificate of acceptance testing.

D. Software licenses.

E. Software and firmware service agreements.

F. Warrantees.

G. System service contact information including service desk representative, service desk manager and operations manager.

H. Operating Manuals:
1. Preventive operation instructions for components of the system as a whole and each component in detail. Manual shall include software and hardware operation and programming. Manuals shall be written to aid in training of new security and operating personnel and as a guide in clarifying operational procedures.

I. Maintenance Manuals:
1. Preventive maintenance program and service instructions for components of the system as a whole and each component, function, and operation in detail. Manuals shall include illustrations, mounting instructions, wiring diagrams, parts lists, operating instructions, and a trouble-shooting chart for the system, including a list of troubles, causes and recommended remedies.
2. Spare Parts List. Submit a list of spare parts and components of critical items for consideration of purchase by the Owner.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Alarm Printer Black/Red Ribbons: Package of twelve.
2. Laser Printers: Three toner cassettes and one replacement drum unit.
3. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
4. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.09 QUALITY ASSURANCE

A. Systems Manufacturer:
   1. Company specializing in manufacturing products specified in this section with minimum five years documented experience.
   2. Capability in assisting in the preparation of engineering and production documentation.
   3. Capability in assisting in the development of testing program and interpretation of test results.
   4. Capable of providing manufacturer-employed field service personnel for installation assistance.
   5. Capable of providing technical service assistance to the Owner upon acceptance of the Work by the Owner.
   6. Capable of providing remote technical service to the Owner upon acceptance of the Work by the Owner.

B. Contractor:
   1. Specializing in the installation, maintenance and support of the system and products specified.
   2. Authorized or franchised installer of specified manufacturer with minimum three years documented experience.
   3. Staff:
      a. System design and Shop Drawings preparation technician certified by the specified Manufacturer.
      b. System device and cable installation technician certified by the specified Manufacturer.
      c. Software installation, programming and integration technicians certified by the specified Manufacturer.
      d. System training technicians certified by the specified Manufacturer. Refer to Part 3, Training and Demonstration.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials indoors, in a clean, dry area in accordance with manufacturer's instructions.

C. Protect material from damage and the entrance of dirt, dust, moisture, and debris.

D. Handling: Protect materials during handling and installation to prevent damage.

1.11 CONTRACT DRAWINGS

A. The contract drawings indicate the general nature of the system layout, but do not show all components required. Rough-in requirements are shown on the contract drawings but

do not show all conduit and back boxes. Conduits, routing, and wiring are not shown on the drawings. Provide as per system requirements and shop drawings.

B. Coordinate back box requirements with system manufacturer/supplier. Study the Architectural drawings to understand wall and ceiling details. Notify Architect prior to installation if conflicts occur between:
1. Back box depth and wall thickness.
2. Wall construction.
3. Back box location.
4. Ceiling construction.
5. Door construction.

1.12 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 50 to 105 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250, Type 3R Type 3S Type 4 enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

1.13 WARRANTY

A. System shall be warranted to be free of defect or faulty workmanship for a minimum period of one year from the date of final acceptance. If any equipment shall fail or found to be inoperative within this period, the contractor shall repair and/or replace within (1) day of the notification with no expense to the owner. Any required maintenance for the

equipment that falls within this warranty period shall also be performed by the contractor at no expense to the owner.

B. After the acceptance of the system(s) service shall be provided on the following basis:

C. Emergency Service - Provided 24 hours a day. When a total or catastrophic failure of equipment is reported to vendor / contractor, within 4 hours of notification, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a master station/console.)

D. Routine Service - Provided within four business hours (9 a.m. to 5 p.m., Monday through Friday, excluding holidays) of notification. When a minor failure of equipment is reported to vendor / contractor, a service person will be on site within 24 hours of notification.

E. Warranty Period: Two years from date of Substantial Completion.

1.14 MAINTENANCE SERVICE

A. Provide service and maintenance of the Physical Identify Access Management System for one year from Date of System Acceptance by the Owner.

1.15 COORDINATION

A. Coordinate the installation of wall and rack mounted components in the existing communication rooms with the Architect and Owner.

B. Coordinate the installation and programming of the system with the doors, gates, and fire barriers Work of Division 07

C. Coordinate the installation and programming of the system with the door hardware Work of Division 08.

D. Coordinate the installation of the system with the Division 26 Work.

E. Coordinate the installation of wall and rack mounted components in the communication rooms with the 27 11 00 Work. Provide information for the completion of Section 27 11 00 Shop Drawings.

F. Coordinate the installation of ceiling mounted sensors, speakers, and strobe lights with the ceiling installation Work. Refer to the Architectural reflected ceiling plan drawings for ceiling details.

G. Coordinate the installation and programming of the system with Section 28 05 30 Work.

H. Coordinate the installation and programming of the system with Section 28 23 00 Video surveillance system Work.

I. Coordinate the programming of the unlocking of doors with Division 28 Fire Alarm System Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Verkada AD Series (Owner Provided Contractor Installed)

2.02 DESCRIPTION

A. Fully integrated and functional access control system with card readers, keypad and key fob reader at each door designated in the security drawings.

B. Scalable platform to support additional credentials, doors, buildings, and sites, then those shown on the Drawings.

C. PC-based central station, one or more networked PC-based workstations, and field-installed controllers, connected by a LAN.

D. System Software: Based on 64-bit, Windows server operating system, and application software. Software shall have the following capabilities:
   1. Multiuser and multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
   2. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of Microsoft Windows.
   3. System license for the entire system including capability for future additions that are within the indicated system size limits specified in this Section.
   4. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows.
   5. Password-protected operator login and access.
   6. Open-database-connectivity compliant.

E. Network connecting the central station and workstations shall be a LAN using Microsoft Windows-based TCP/IP with a capacity of connecting up to 99 workstations. System shall be portable across multiple communication platforms without changing system software.

F. Network(s) connecting PCs and controllers shall consist of one or more of the following:
   1. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet, star topology network based on TCP/IP.
   2. Direct-connected, RS-232 cable from the COM port of the central station to the first controller, then RS-485 cable to interconnect the remaining controllers at that Location.

3. Dial-up and cable modem connection using a standard cable or dial-up telephone line, for redundancy only.

2.03 OPERATION

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: A fully distributed processing system.
1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
2. Intermediate controllers for access control are prohibited.
3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.

C. Number of Locations:
1. Support at least 1,000 separate Locations using a single PC with combinations of direct-connect, dial-up, or TCP/IP LAN connections to each Location.
2. Each Location shall have its own database and history in the central station.
3. Locations may be combined to share a common database.

D. System Network Requirements:
1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
4. Communications controller may be used as an interface between the central-station display systems and the field device network. Communications controller shall provide functions required to attain the specified network communications performance.

E. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers.

F. Field equipment shall include controllers, sensors, and controls.
1. Controllers shall serve as an interface between the central station and sensors and controls.
2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.

3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
4. Controllers are classified as alarm-annunciation or entry-control type.

G. System Response to Alarms:
1. Field device network shall provide a system end-to-end response time of 500milli second(s) or less for every device connected to the system.
2. Alarms shall be annunciated at the central station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the central station.
3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the central station.
4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
5. This response time shall be maintained during system heavy load.

H. False-Alarm Reduction: The design of the central station and controllers shall contain features to reduce false alarms.

I. Error Detection:
1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
2. Interactive or product error-detection codes alone will not be acceptable.
3. A message shall be in error if one bit is received incorrectly.
4. Retransmit messages with detected errors.
5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
6. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
7. Monitor the frequency of data transmission failure for display and logging.

J. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

K. Door Hardware Interface:
1. Comply with requirements in Division 08 Sections for door hardware required to be monitored or controlled by the security access system.
2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

2.04 APPLICATION SOFTWARE

A. System Software: Based on 64-bit, Microsoft Windows central-station and workstation operating system and application software.
1. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.

2. Graphical user interface shall show pull-down menus and a menu-tree format.
3. Capability for future additions within the indicated system size limits.
4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
5. Password-protected operator login and access.

B. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors and DTS links, operate displays, report alarms, generate reports, and help train system operators.
1. Reside at the central station, workstations, and controllers as required to perform specified functions.
2. Operate and manage peripheral devices.
3. Import custom icons into graphics to represent alarms and I/O devices.
4. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host PC. This operation shall be at the controller.
5. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host PC. This operation shall be at the controller.
6. Selectable poll frequency and message time-out settings shall manage bandwidth and latency issues for TCP/IP, RF, and other PC-to-controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
7. Automatic and encrypted backups for database and history backups shall be automatically stored at the central-control PC server and encrypted with a nine-character alphanumeric password that must be used to restore or read data contained in backup.
8. Operator audit trail for recording and reporting all changes made to database and system software.
9. Support network protocol and topology, TCP/IP, Novel Netware, Digital Pathworks, Banyan Vines, LAN/WAN, and RAS.

C. Client Workstation Software:
1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not managed by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

D. Controller Software:
1. Controllers shall operate as autonomous, intelligent processing units.
   a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
   b. Controllers shall be part of a fully distributed processing-control network.

c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.

2. The following functions shall be fully implemented and operational within each controller:
   a. Monitoring inputs.
   b. Controlling outputs.
   c. Automatically reporting alarms to the central station.
   d. Reporting of sensor and output status to the central station on request.
   e. Maintaining real time, automatically updated by the central station at least once a day.
   f. Communicating with the central station.
   g. Executing controller resident programs.
   h. Diagnosing.
   i. Downloading and uploading data to and from the central station.
3. Controller Operations at a Location:
   a. Up to 64 controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the central station or workstations are off-line.
   b. In the event of communication failure between the central station and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
   c. Buffered events shall be managed in a first-in-first-out mode of operation.
4. Individual Controller Operation:
   a. Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission to the central station. Storage capacity for the latest 1024 events shall be provided at each controller.
   b. Card-reader ports of a controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
   c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
   d. Controllers that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.

e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.

5. Communications Monitoring:
a. System shall monitor and report status of TIA 485-A communications loop of each Location.
b. Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.
c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.

6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

E. PC-to-Controller Communications:
1. TCP/IP.

2.05 SYSTEM DATABASE

A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.

B. Database Operations:
1. System data management shall be in a hierarchical menu-tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
2. Navigational Aids:
a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
b. Point and click feature to facilitate data manipulation.

c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.

3. Data entry shall be automatically checked for duplicate and illegal data and shall be verified for valid format.
4. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose for which the item was entered, reasons for changes that were made, and the like.

C. Operator Passwords:
1. Support up to 100 individual system operators, each with a unique password.
2. One to eight alphanumeric characters.
3. Allow passwords to be case sensitive.
4. Passwords shall not be displayed when entered.
5. Passwords shall have unique and customizable password profile and allow several operators to share a password profile. Include the following features in the password profile:
a. Predetermine the highest-level password profile for access to all functions and areas of program.
b. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
c. Restrict doors to which an operator can assign access.
6. Operators shall use a username and password to log on to system. This username and password shall be used to access database areas and programs as determined by the associated profile.
7. Make provision to allow the operator to log off without fully exiting program. User may be logged off, but program will remain running while displaying the login window for the next operator.

D. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).
1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
2. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
3. Allow assignment of multiple cards/codes to a cardholder.
4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
5. Each door may be assigned four time zones.
6. Access codes may be up to 11 digits in length.
7. Software shall allow the grouping of locations so cardholder data can be shared by all locations in the group.

8. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
9. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visible annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
10. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9999 that regulates the number of times the card can be used before it is automatically deactivated.
11. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

2.06 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.

B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.

C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Alarm Annunciation Controller:
1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network, with dc line supervision on each of its alarm inputs.
   a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
   b. Alarm-Line Supervision:
      1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 percent or more for longer than 500 ms.
      2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.
   c. Outputs: Managed by central-station software.

E. Entry-Control Controller:
1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate, and door operators, and exit push buttons.

a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
    1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
    2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:
    a. Data from entry-control devices; use this input to change modes between access and secure.
    b. Database downloads and updates from the central station that include enrollment and privilege information.
3. Outputs:
    a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
    c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.
    d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.
4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
    a. Store up to 1000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
    a. Backup Battery: Premium, valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 9-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery

terminal voltage and charging current recommendations for maximum battery life.

b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

c. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.

d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
   1) Trouble Alarm: Normal power-off load assumed by battery.
   2) Trouble Alarm: Low battery.
   3) Alarm: Power off.

2.07 CARD READERS, CREDENTIAL CARDS

A. Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
   1. Indoors, controlled environment.
   2. Indoors, uncontrolled environment.
   3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Proximity Readers:
   1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction and shall receive and decode a unique identification code number transmitted from the credential card.
   2. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.

3. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.

2.08 CARD READER, CARD READER/KEYPAD.

A. MultiCLASS SE SEOS.

B. Size:
1. Standard U.S. switch plates size.
2. Window mullion mount.

C. Communications:
1. Open supervised device protocol (OSDP).
2. Wiegand.

D. Outdoor IP65 rated, complete with rubbers gaskets.

E. Power requirements: 5-16 VDC.

F. Dimensions: 4.7 inch by 3.0 inch by 0.68 inch.

G. Read Range: up to 5.5 inch.

H. Manufacturer:
1. Verkada Allegiance

2.09 DOOR WIRELESS LOCKING HARDWARE WITH INTEGRATED CARD READER (REFER TO DIVISION 8)

2.10 REQUEST-TO-EXIT SENSOR

A. Manufacturers:
1. Verkada Allegiance

B. Passive infrared motion detector with trim plate with dry contact indication to the access control system.
1. Adjustable timed relay output.
2. Swivel mount for attachment to wall, ceiling, or door frame.
3. Double pole, double throw relay contacts.

2.11 CREDENTIAL CARDS

A. Credential Card: Owner Provided

2.12 AUTO DOOR CONTROLLER (REFER TO DIVISION 8)

2.13 MAGNETIC DOOR CONTACT/SENSOR

A. 3/4-inch diameter, magnetic contact., wire leads single pole/single throw with 3/8-inch gap.

B. Color: Coordinate with the Architect.

C. Manufacturer List:
1. Verkada Allegiance

2.14 DURESS-ALARM SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
1. Verkada Allegiance

B. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
1. Minimum Switch Rating: 50,000 operations.
2. Foot Rail: Foot activated, floor mounting.
3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

C. Power: Push-button switches shall be powered from their associated controller, using DC control.

2.15 REMOTE DOOR CONTROLLER

A. Door controller.

B. Supported via 4-pair cable connected to a network switch.

2.16 POWER SUPPLIES, TRANSFORMERS AND BATTERY BACK UP

A. NFPA 70, Class II control transformers, NRTL listed.

2.17 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Division 08 Section "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware."

E. Vehicle Gate Operator: Interface electrical operation of gate with controls in this Section. Vehicle gate operators shall be connected, monitored, and controlled by the security access controllers. Vehicle gate and accessories are specified in Division 32 Section "Chain Link Fences and Gates."

2.18 FLOOR-SELECT ELEVATOR CONTROL

A. Elevator access control shall be integral to security access.
   1. System shall be capable of providing full elevator security and control through dedicated controllers.
   2. Access-control system shall enable and disable car calls on each floor and floor-select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.
   3. System setup shall, through programming, automatically and individually secure and unsecure each floor-select button of a car by time and day. Each floor-select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
   4. When a floor-select button is secure, it shall require the passenger to use his or her access code and gain access to that floor before the floor-select button will operate. The passenger's credential shall determine which car call and floor-select buttons are to be enabled, restricting access to floors unless authorized by the system's access code database. Floor-select button shall be enabled only in the car where the credential holder is the passenger.

B. Destination Dispatch Software Integration to support Bid Alternate No. 1, referenced in Alternates Section 01 23 00, Part 1.04.A: Ensure Software Integration exists between Johnson Controls and the successful selected elevator manufacturer referenced in Section 14 20 10, Part 1.12.A.

C. Security access system shall record which call button is pressed, along with credential and time information.
   1. System controller shall record elevator access data.
   2. The controller shall reset all additional call buttons that may have been enabled by the user's credential.
   3. The floor-select elevator control shall allow for manual override from a workstation PC either by individual floor or by cab.

D. CABLES
1. Cables compliant with requirements as recommended by system manufacturer for installation and integration.
2. Composite cable consisting of 4-conductor (18 AWG), 4-conductor (22 AWG), 3 pair (22 AWG) and 2 conductor (22 AWG shielded) shall be provided from access control/power supply panels to doors being fitted with card reader or card reader/keypads.
3. Cables rated for the environment of which they are installed.

E. PLYWOOD BACKBOARDS
1. 3/4-inch fire treated, exterior grade Douglas Fir A-C plywood, void free, sized with a minimum of 6 inches of clearance on all sides of wall mounted devices.
2. Plywood backboards stamped by the manufacturer to identify fire rating.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with vendor’s/manufacturers' instructions for installing components, devices, accessories, cable, and wire and for adjusting and programming the components.

B. Keep items protected before and after installation, with dust and waterproof barrier materials, as necessary. Maintain the integrity of the protective measures throughout the life of the project.

C. Protect cable and equipment from damage, at-all-times during the construction. Do not install cables and equipment in the communications rooms until the other trades have completed their work in the areas so that the equipment will not be moved or damaged. Do not install cable and equipment in communications rooms until after plywood backboards have been painted.

D. Examine conduit and back box rough-in provisions for doors to support cable and equipment to validate actual requirements prior to installation. Refer to door rough-in detail drawings for conduit and back box -in provisions. Identify required deviations to conduit and back box provisions to meet specific door requirements and coordinate changes to the conduit and back box requirements with the Section 28 05 30 Work prior to commencement of Work.

E. Provide safety slack wires from ceiling mounted devices to structure above as per applicable codes.

F. Maintain safe ingress and egress from work areas during the movement and installation. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work. Where a remedy of unsatisfactory conditions is not available or

possible, notify the Architect for resolution. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INTERFACE WITH FIRE ALARM SYSTEM

A. Interface the system with the fire alarm system to unlock doors upon activation of the fire alarm system as required by Codes

3.03 PREPARATION

A. Obtain detailed Project Planning forms and templates from the Manufacturer(s). Develop and customize the forms and templates to suit the Project. Publish as Project Planning Documents for review and approval.

B. Prior to commencement of the system installation, schedule meetings with Architect and Owner:
   1. Present project planning documents and review, adjust, and prepare setup documents. Use final documents to set up and program the system and video surveillance software.
   2. Review and discuss current electronic security system policies and procedures.
   3. Confirm exact location of door controller and power supply enclosures in the communication room. Record setup of controller features and access requirements.
   4. Confirm exact location of gates, controller motors, and power supply enclosures near the gates. Record setup of controller features and access requirements.
   5. Confirm exact location of card readers and door interface devices.
   6. Coordinate how wireless locks with integrated card readers, will be installed, connected to the Owner’s network, and programmed into the expanded system.
   7. Coordinate how auto-door operators will integrate and be controlled by card reader(s).
   8. Coordinate how fire doors/barriers and associated operators will integrate into and be controlled by card reader(s).
   9. Coordinate how roll up gate and associated operators will integrate into and be controlled by card reader(s).
   10. Coordinate how vehicular and pedestrian gate operators will integrate into and be controlled by card reader(s).
   11. Coordinate door profiles and schedules.
   12. Coordinate rules, response actions and schedules.
   13. Coordinate updating system map-views
   14. Coordinate pin codes for dual authorization keypads.
   15. Confirm start and stop times for time zones and holidays and match up access levels for doors.
   16. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
   17. Develop user-defined fields.
   18. Develop screen layout formats.
   19. Assign action message names and compose messages.

20. Set up alarms.
21. Establish interlocks between alarms, intruder detection, and video surveillance features.
22. Coordinate the system response to fire alarm system activation.
23. Coordinate the system response to call for “lock down” activation.
24. Assign action message names and compose messages.
25. Prepare and install alarm graphic maps.
26. Coordinate graphical user interface screen layout formats
27. Coordinate how door activation/alarms will trigger video surveillance camera screen pop-ups on security office video displays.
28. Coordinate how management reports and incident reports will set up and managed.
29. Coordinate software and license requirements and acceptance.
30. Coordinate setup data for control station and workstations.
31. Coordinate credential/badge layout options and design.
32. Propose setups for guard tours and key control.
33. Coordinate default system and devices logins and passwords, and how they will be changed to Owner logins and passwords.
34. Coordinate network switch port requirements to connect video surveillance cameras into the network.
35. Coordinate controller network address requirements.
36. Coordinate cable, controller, and card reader labeling nomenclature.
37. Coordinate video surveillance camera naming for video management system programming
38. Coordinate card reader and door naming for system programming.
39. Coordinate a plan for system testing, startup, and demonstration.
40. Develop acceptance test concept and, on approval, develop specifics of the test.
41. Record and share decisions for approval and acceptance by the Architect and Owner.
42. Coordinate the Work schedule and the sequence of Work.

C. Secure software licenses.

3.04 EXISTING WORK

A. Extend existing access control system using materials and methods compatible with existing installations, or as specified.

B. Coordinate the interfacing of the new system components with the existing systems with the Owner prior to the commencement of any work.

3.05 EXISTING SYSTEM

A. Conduct a site visit with the Architect and Owner prior to commencement of Work.
   1. Review the build and performance of the system server(s) currently in use.
   2. Suggest modifications to the current system server to enhance current performance and to enhance performance of the expanded system.

3. Review the build and performance of the management workstation currently in use.at the security desk.
4. Suggest modifications to the current management workstation to enhance current performance and to enhance performance of the expanded system.
5. Review operation and setup of the current security desk currently in use.
6. Suggest modifications to the current security desk to enhance current operation and to enhance operation of the expanded system.
7. Review operational parameters of the system.
8. Review conditions of the field panels currently in use and confirm that the field panels were professionally installed.
9. Suggest modifications to the current field panel installation that were not professionally installed.

B. Perform operational tests to confirm that the system is properly functioning and to set a minimum base line for final system acceptance.

C. Confirm that the system database is properly backed up. Create a second backup of the system database in case of a failure to properly load the primary database.

D. Expand the existing access control system using materials and methods compatible with existing installations.

E. When tying into existing power supplies, confirm existing loads and new loads do not exceed the rating of the power supplies.

F. Update Credentialed Access Control Management System software to the latest software release.

3.06 INSTALLATION

A. Coordinate the integration of the access control with the Architect, Owner and other Division 28 system identified herein.

B. Coordinate the interfacing of the new system components with the existing systems with the Owner prior to the commencement of Work. Identify impact to operations and provide a schedule of Work.

C. Integrate magnetic door contact/sensors into the access control system and intrusion system.

D. Confirm compatibility of the new devices with the existing system. Report compatibility issues to the Architect.

E. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Provide components needed for a complete system.

F. Door Hardware Interface:
   1. Comply with requirements in Divisions 01 and 08 for door hardware required to be monitored or controlled by the credentialed access control management system, including request to exist devices and latch-bolt monitor devices.
   2. Match the electrical characteristics of controllers with the signal and power requirements of door hardware.

G. Gate Hardware Interface:
   1. Comply with requirements in Divisions 01, 11 and 32 for gates and gate hardware required to be monitored or controlled by the credentialed access control management system, including request to exist devices and buttons, induction loops, gate motors and gate position monitor devices.
   2. Match the electrical characteristics of controllers with the signal and power requirements of gate hardware.

H. Provide controllers, relays, power supplies, battery backup and enclosures in identified rooms and mount onto new plywood back board. Dress cables entering the rooms with strain relief and anti-chaffing equipment; separated from the cabling for other devices not associated with the access control equipment. Do not obstruct equipment controls or indicators with wire or cable. Route wire and cable away from heat producing components such as resistors, regulators, and the like.

I. If replacing the access control system, provide new controllers/enclosures in identified rooms and mount onto new plywood back board. Re-dress the cables.

J. Provide card readers, magnetic door contact/sensors, relays, sounders, power supplies, controllers, and enclosures. Ground the system components as required.

K. Provide new magnetic door contact/sensors to replace the existing magnetic door contact/sensors and cable the magnetic door contact/sensors to both the access control controller and the intrusion detection controller. Modify door frame to accommodate new contact/sensors.

L. Provide electronic door operator relays/enclosures at doors with existing electronic door operators. Locate the relays/enclosures above the accessible ceilings above the doors. Where the ceiling above the doors is in-accessible, locate the relays/enclosures near the door.

M. Provide a cable termination scheduled for cable and terminations installed under this Work. Coordinate schedule schema with Architect prior to commencement. Record cable schedules in an excel spreadsheet. Provide a copy of the spreadsheet on a CD to Owner prior to Project Close-out.

N. Provide cable and wire to interconnect devices. Size cable and wire to maintain voltage drop and resistance, at levels acceptable to the manufacturer and for proper installation of the system.

O. Route cables from the doors to the controllers in conduits, raceway, and cable trays. Provide J-hooks to support the cables in accessible ceiling areas were where conduits and cable tray are not available.

P. Provide plenum rated cable in environmental airspaces, including plenum ceilings.

Q. Install cables in continuous length. Do not splice cables.

R. Provide cables to network the access control system controllers to Owner network switches in the communication rooms. Refer to Section 27 15 00.

S. Provide cables to network the access control system controllers to the existing access control system presently installed in the buildings.

T. Label devices signifying equipment location number in correspondence with the cable termination schedule and the as-built diagram with machine generated self-laminating labels.

U. Label cables at each end signifying equipment location number in correspondence with the cable termination schedule and the as-built diagram with machine generated self-laminating labels

3.07 SYSTEM PROGRAMMING

A. Load background files into the credentialled access control management system to include the site, building, floors, and doors.

B. Program the existing access control system software to include new controllers, doors, gates, card readers, and wireless locks with integrated card readers .Coordinate programming requirements with the Owner:
1. Door type grouping.
2. Door locking:
   a. Fail secure/fail safe.
   b. Normally open/normally closed.
   c. Multiple points of control.
3. Operating hours.
4. Interface to remote operation devices:
   a. Lock down buttons.
   b. Remote unlock buttons.
   c. Intercom stations.
5. Door alarm reporting.
6. Door alarm shunting reset period.
7. Delayed egress.
8. Staff type access to each door.
9. Interface to auto door operators.
10. Device operations sequencing.]

C. Program the existing credentialled access control management system software to include new devices. Coordinate # nomenclature and room number nomenclature with Owner prior to commencement.

D. Program operational sequence of door:
   1. Time of operation for securing doors.
   2. Time of operation for un-securing doors.
   3. Timeframe for door open in a non-alarm condition.

E. Program credential templates for access levels. Coordinate door/department/credential access level with Owner prior to commencement.

F. Provide initial programming and configuration of the system including: the definition of the following.
   1. Hardware.
   2. Doors.
   3. Fire doors/barriers .
   4. Gates.
   5. Monitor points.
   6. Clearance codes.
   7. Time codes.
   8. Door groups.
   9. Alarm groups.
   10. Operating sequences.
   11. Camera call-ups.

G. Coordinate operating parameters with Architect and Owner.

H. Prefer to minutes of meetings from Preparation meetings for other programming requirements.

I. Develop and input system graphics, maps and standby screens using Architect provided floor plan. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits.

J. Input credential data for each access card. Coordinate credential information parameters with Owner.

K. Maintain hard copy worksheets of the system program and configuration until final acceptance by Owner. Worksheets shall be subject to inspection and approval by Owner. Provide final copies to Owner prior to Project Close-out.

L. Maintain electronic backups of the system configuration and cardholder database until final Acceptance by Owner. Provide back-up tapes at final acceptance.

M. Approximately sixty (60) days after occupancy, provide on-site follow-up assistance with system configuration. Contractor shall include an allowance of sixteen (16) hours of labor for follow-up assistance in his Base Bid price.

3.08 APPLICATION SERVERS

A. If replacing the access control system, provide an application server(s) for the replacement Access Control System software and database storage. Coordinate location of server(s) with the Owner prior to installation.

3.09 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method:
1. Install wiring in conduits and cable tray except within consoles, cabinets, desks, and counters.
2. Provide NRTL-listed plenum cable in environmental airspaces, including plenum ceilings.

3.10 CONDUIT AND BACK BOXES

A. Provided lockable enclosures pull boxes where enclosures and pull boxes are accessible to employees or to the public. Refer to Section 28 05 28 for additional information.

B. Card Readers and Keypads:
1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

3.11 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:
   1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
   2. Bus: Mount on wall of main equipment room with standoff insulators.
   3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.12 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Division 26 section "Identification for Electrical Systems" and with TIA/EIA 606-A.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

C. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the device as shown.

D. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

E. Label control and power supply panels in accordance with the approved Shop Drawings with machine generated self-laminating labels.

F. Label card readers in the inside of the devices in accordance with the approved Shop Drawings with machine generated self-laminating labels.

3.13 FIRESTOPPING

A. Provide Firestopping systems at rated walls and floors where system’s cables are run.

B. Comply with requirements in Division 01, [Section [07 84 13]] "Penetration Firestopping."

C. Comply with TIA-569 "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.14 FIELD QUALITY CONTROL

A. Provide a quality control and testing plan to the Owner a minimum of 2, weeks in advance of commence of the testing. Include tester credentials, and system test schedules and system test documentation templates.

B. Test each circuit and component of each system. Measure the power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time.

C. Perform field inspections and operational test on each component or item of equipment and on the overall system. Minimum system testing shall include the following.
   1. Operation of each card reader.
   2. Operation of each door.
   3. Operation of fire doors/barriers .
   4. Operations of vehicular and pedestrian gates.
   5. Operations of roll up gates.
   6. Operation of each duress & alarm station.
   7. Operation of each intercom station remote door release.
   8. Operation of the system in a lock down alarm sequence.
   9. Operation of the system in an active fire alarm activation sequence.
   10. Operation of the system in infant security system activation sequence.
   11. Operation of elevator cab-recall alarm sequence.
   12. Operation of the system in a manual operation mode.
   13. Operation of all safety features of the systems.
   14. Operation of system under power failure conditions.
   15. Operation of system under central control unit failure.

D. Validate the end user permission programming at the viewing stations scheduled for the security desks.

E. Assess each circuit and component of each system. Tests shall include measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

F. After installation of cables and connectors, demonstrate product capability and compliance with requirements. Assess each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests are completed.

G. Inspect the system to verify that components devices are labeled, and the interconnecting cables, wires and terminals are labeled and identified.

H. Prepare test and inspection reports and submit under Article “Closeout Submittals.”

3.15 STARTUP SERVICE

A. Complete installation and startup checklist according to approved procedures developed in "Preparation" Article and with manufacturer's written instructions.

B. Adjust system controls and programming to achieve proper operation

3.16 DEMONSTRATION

A. Provide a training plan to Architect and Owner a minimum of six weeks in advance of commence of the training sessions. Include trainer credentials, training schedules with quantity of classes and durations and training materials for approval by the Owner.

B. Demonstrate system operation to the Owner’s Security Staff and Facilities Engineer.

C. Conduct walking tour of Project with the Architect and Owner to describe and review function, operation, maintenance, and warranty of each component.

D. Provide a minimum of two, 4-hour classroom training session(s) for the Owner’s systems operators on the Owner’s site. The sessions shall include:
1. Training outline, agenda, and training material for (#) people.
2. System operation manuals.
3. System programming manuals.
4. Demonstrate system operations, management, features, and component programming.
5. Cover operating features of the system, including the following.
    a. Data base back up procedures and scheduling.
    b. System set-up and cardholder database configuration.
    c. Access control features.
    d. Alarm monitoring features.
    e. Report generation and searches.
    f. Card management.

E. Use submitted operation and maintenance manual as reference during demonstration and training.

3.17 END OF S OPERATION AND MAINTENANCE MANUALS

A. Provide product, user and operation manuals provided by the manufacturer to contain the following.
1. Preventive maintenance program.
2. Service instructions for components of the system and each component, function, and operation in detail.
3. Illustrations, mounting instructions, wiring diagrams, parts lists, operating instructions, and a trouble-shooting chart for the system, including a list of troubles,

causes and recommended remedies. Include wiring diagram showing all components.

B. Manuals shall be written to aid in training of new security and operating personnel and as guide clarifying operational procedures.

C. Spare Parts List. Submit list of spare parts and components of critical items for consideration of purchase by Owner.

3.18 WARRANTY

A. Register and provide proof-of-purchases required to activate Manufacturer's warranty.

B. The warranty shall include labor and equipment to maintain the integrated system in full operation for a period of one year for hardware from the date of Owner acceptance.

C. The warranty shall provide:

D. A contact number for service call during the warranty period that is answered 24 hours 7 days a week. Service calls made outside of normal working hours and received by an answering service shall be returned within 1 hour.
1. Standard on-site service calls within 12 hours.
2. Emergency on-site service calls within 4 hrs.
3. The end-user will notify the contractor of the appropriate response time required. This warranty may be enhanced by the contractor but cannot be taken away from this supersedes all other warranties.

E. Invoke manufacturer's warranties as necessary during the warranty period. Obtain Return-Merchandise-Authorization for shipping defective material back and receiving replacements materials

END OF SECTION

SECTION 28 23 00 - VIDEO SURVEILLANCE MANAGEMENT SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The Work under this Section includes furnishing materials, equipment, labor, supervision, tools, licenses and items necessary for the design, construction, installation, connection, programming, integration, licensing, programming, testing and operation of video surveillance management system.

B. The Work under this Section includes furnishing materials, equipment, labor, supervision, tools, licenses and items necessary for the design, construction, installation, connection, programming, integration, licensing, programming, testing and operation of video surveillance cameras.

1.02 SYSTEM DESCRIPTION

A. Video surveillance cameras integrated into an existing video management system.

B. The Owner is currently using the following.
   1. A Video Management System by Verkada
   2. Credentialed Access Control Management System (CACMS) by Verkada

C. The Video Management System programming modified for new video surveillance cameras, storage/server/network video recorder devices.

D. The Video Management System updated to the latest offered version available.

E. The firmware on existing video surveillance cameras updated to the latest offered version.

F. Video image storage updated or added to accommodate new video surveillance cameras.

G. Licenses associated with new components and software.

1.03 RELATED WORK

A. Division 07, Section “Firestopping.

B. Section 27 11 00, Communication Equipment Room Fittings.

C. Section 27 1500, Communication Horizontal Cabling.

D. Section 28 13 00, Credentialed Access Control Management System.

1.04 REFERENCES

A. Abbreviations
1. AGC - Automatic Gain Control
2. API – Applications Programming Interface
3. ARP – Address Resolution Protocol
4. AWB - Automatic White Balance
5. BLC – Back Light Compensation
6. CBR – Constant Bit Rate
7. CCD: Charge-coupled device.
8. CVBR – Constant and Variable Bit Rate
9. DHCP - Dynamic Host Configuration Protocol
10. DNR – Digital Noise Reduction
11. DNS - Domain Name Server
12. EAP – Extensible Authentication Protocol
13. fps - frames per second
14. FTP - File Transfer Protocol
15. GUI – Graphical User Interface
16. HTTP - Hypertext Transfer Protocol
17. HTTPS – Secure Hypertext Transfer Protocol
18. ICMP – Internet Control Message Protocol
19. IGMP - Internet Group Management Protocol
20. IP - Internet Protocol
21. JPEG - Joint Photographic Experts Group
22. LDAP – Lightweight Directory Access Protocol
23. MJPEG - Motion JPEG
24. MPEG - Moving Pictures Experts Group
25. NTP - Network Time Protocol
26. PoE - Power over Ethernet
27. PPPoE - Point-to-Point Protocol over Ethernet
28. PTZ: Pan-tilt-zoom.
29. QoS – Quality of Service
30. RAID: Redundant array of independent disks.
31. RTP - Real-Time Transport Protocol
32. RTSP - Real-Time Streaming Protocol
33. SMTP - Simple Mail Transfer Protocol
34. SNMP – Simple Network Management Protocol
35. SSH – Secure Shell
36. SSL – Secure Sockets Layer
37. TCP - Transmission Control Protocol
38. UDP - User Datagram Protocol
39. UPnP – Universal Plug and Play
40. UPS: Uninterruptible power supply.
41. VBR – Variable Bit Rate

42. WDR – Wide Dynamic Range
43. VMS - Video Management System
44. WDR – Wide Dynamic Range

B. Reference Standards
   1. Network
      a. IEEE
         1) 802.3 Ethernet Standards
         2) 802.1x – Port-based authentication
   2. Video
      a. ISO / IEC 14496 –10, MPEG-4 Part 10 (ITU H.264)
      b. ISO / IEC 10918 – JPEG
      c. ONVIF – Profile S, Profile G, and Profile Q
   3. Emissions
      a. FCC (Class A) – 47 CFR Part 15
      b. CE – EN 55022 (Class A), EN 50130-4, EN 60950-1
      c. ICES-003, Class A
   4. Environmental Models
      a. ANSI / IEC 60529 – Degrees of Protection Provided by Enclosures – IP66
      b. IK10 (20J) Impact Resistance / IEC62262
      c. National Electrical Manufacturers Association, NEMA 250-2003, 4X Enclosure Definition
   5. Electrical Components, Devices, and Accessories:
      a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.05 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.06 ACTION SUBMITTALS

A. Product Data:
   1. Materials list.
   2. Technical data (cut sheets) for on each component, including finishes and weights.

B. Calculations:
   1. Network bandwidth projected requirements by camera, by communication room.
   2. UPS sizing.

C. Shop Drawings:
   1. Description of system operation
   2. Plan views for all devices shown on floor plans coordinated with the Architectural reflected ceiling plans.

3. Wiring and cabling diagrams.
4. Conduit and back box schedules.
5. Details for video surveillance camera seismic supports where seismic supports are required by Codes.
6. Detail equipment assemblies of devices and camera mounts and enclosures.

D. Equipment List: Include equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

E. Deferred Submittals:
1. Network connection requirements.
2. Network address requirements.
3. Manufacture's system installation instructions and programming templates.
4. System test plan and schedule.
5. System training plan and schedule.

F. Documentation:
1. Software license description.
2. Software license list, including quantities provided and duration of authorization.

G. Certifications:
1. Certificates of training by the Manufacturer for technicians assigned and working on the Project.

H. Schedule of Values:
1. A schedule of values for furnished and installed unit costs for each basic and optional system component and software component. The schedule of values shall include hardware components, software components, component part numbers, component quantities, and furnish & install unit prices.

1.07 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.08 CLOSEOUT SUBMITTALS

A. Provide in accordance with Section 28 05 00 - Common Work Results for Electronic Safety and Security Systems.

B. Project Record Documents
1. Record actual information of the installed Work.
2. Product data.
3. Floor plans identifying devices, devices IDs and raceway routing.
4. Cable termination schedules for associated horizontal cables.
5. System sequence of operations.
6. System programming manual/sheets.
7. Component programming manual/sheets.
8. Test procedures and results.

C. Certificate of acceptance testing.

D. Warrantees.

E. System service contact information including service desk representative, service desk manager and operations manager.

F. Operating Manuals:
1. Preventive operation instructions for components of the system as a whole and each component in detail. Manual shall include software and hardware operation and programming. Manuals shall be written to aid in training of new security and operating personnel and as a guide in clarifying operational procedures.

G. Maintenance Manuals:
1. Preventive maintenance program and service instructions for components of the system as a whole and each component, function and operation in detail. Manuals shall include illustrations, mounting instructions, wiring diagrams, parts lists, operating instructions and a trouble-shooting chart for the system, including a list of troubles, causes and recommended remedies.
2. Spare Parts List. Submit a list of spare parts and components of critical items for consideration of purchase by the Owner.

1.09 CONTRACT DRAWINGS

A. The contract drawings indicate the general nature of the system layout, but do not show all components required. Rough-in requirements are shown on the contract drawings but do not show all conduit and back boxes. Conduits, routing and wiring are not shown on the drawings. Provide as per system requirements and shop drawings.

B. Coordinate back box and camera mounting requirements with system manufacturer/supplier. Refer to the Architectural drawings to understand wall and ceiling construction details. Notify Architect prior to installation if conflicts occur between:

1. Back box depth and wall thickness.
2. Wall construction.
3. Back box location.
4. Ceiling construction.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect material from the entrance of dirt, dust, moisture and debris

1.11 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

E. Systems Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

F. Contractor:
1. Company specializing in the installation, maintenance and support of the system and products specified.
2. Authorized or franchised installer of specified manufacturer with minimum three years documented experience.
3. Staff:
   a. System design and Shop Drawings preparation technician certified by the specified Manufacturer.
   b. System device and cable installation technician certified by the specified Manufacturer.
   c. Software installation, programming and integration technicians certified by the specified Manufacturer.
   d. System training technicians certified by the specified Manufacturer. Refer to Part 3, Training and Demonstration.

1.12 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 3R Type 4 enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.13 COORDINATION

A. Coordinate the installation and programming of the video surveillance cameras into the existing video management system with the with the Architect and Owner.

B. Coordinate the patching of horizontal cable termination to Owner network switches in the existing communication rooms with the Architect and Owner.

C. Coordinate the installation of video surveillance cameras with the Section 27 15 00 (Horizonal Cable) Work.

D. Coordinate the integration of the video surveillance cameras with the Section 28 13 00 (Credential Access Control) Work.

E. Coordinate the installation of the video surveillance cameras with the Owner and their network engineers for network port access, provisioning and IP network address requirements.

1.14 WARRANTY

A. The warranty shall include labor and equipment to maintain the integrated system in full operation for a period of one year for hardware from the date of final system acceptance.

B. The warranty shall provide:
   1. A contact number for service call during the warranty period that is answered 24 hours 7 days a week. Service calls made outside of normal working hours and received by an answering service shall be returned within 1 hour.
   2. Standard on-site service calls within 12 hours.
   3. Emergency on-site service calls within 4 hrs.
   4. The end-user will notify the contractor of the appropriate response time required. This warranty may be enhanced by the contractor but cannot be taken away from this supersedes all other warranties.

C. The warranty shall provide a one (1) year parts/labor warranty for the system with the option to extend for up to two (2) years at an additional cost. Maintenance and/or repairs shall be handled directly under this Work during this warranty period. Warranty period will begin on system acceptance by the Owner of a commissioned system.

D. Register and provide proof-of-purchases required to activate Manufacturer's warranty.

E. Invoke Manufacturer's warranties as necessary during the warranty period. When required, obtaining Return Merchandise Authorization when shipping defective material and receiving replacements.

1.15 SYSTEM PRICING:

A. Provide a schedule of values for furnished and installed unit costs for each basic and optional system component and software component by part number.

1.16 SERVICE CONTRACT

A. Provide a one-year service contract to commence after acceptance of installation without additional cost. Service to include two semi-annual visits to the site for routine adjustment and maintenance of all equipment. Provide a preliminary schedule for the semi-annual visits.

B. Toward the end of each year's Service Contract, provide the owner with a proposal for continued service during the next year.

1.17 MAINTENANCE SERVICE

A. Provide service and maintenance of the upgraded video management system for one year from Date of System Acceptance by the Owner.

PART 2 - PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
   1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits." as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.02 NETWORK CAMERAS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings and specified herein:
   1. Verkada (Owner Provided Contractor Installed)

B. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks
   1. System shall have seamless integration of all video surveillance and control functions.
   2. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
   3. System design shall include all necessary compression software for high-performance, dual-stream, video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
   4. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
   5. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
   6. System interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

C. Transmission

1. HTTP (Unicast)
2. HTTPS (Unicast)
3. RTP (Unicast & Multicast)
4. RTP over RTSP (Unicast)
5. RTP over RTSP over HTTP (Unicast)

D. Support Quality of Service (QoS) to prioritize traffic.

E. Video streaming
   1. Multiple, individually configurable streams in H.264 and H.265
   2. Controllable frame rate and bandwidth
   3. VBR/ABR/MBR H.264

F. Password protection, IP address filtering, HTTPS encryption, IEEE 802.1X (EAP-TLS) network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware

G. Supported protocols :IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTP/2, HTTPS, TLS, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP, SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, RTSP, RTP, SRTP, SFTP, TCP, UDP, IGMPv1/v2/v3, RTCP, ICMP, DHCPv4/v6, ARP, SOCKS, SSH, LLDP, CDP, MQTT v3.1.1, Syslog, Link-Local address (ZeroConf)

H. Open application programming interface (API) for software integration

I. Supporting ONVIF® Profile G, ONVIF® Profile S and ONVIF® Profile T.

J. Event triggers:
   1. Detectors, hardware, input signal, storage, system, time, analytics, edge storage events MQTT subscribe.

K. Fixed Indoor, Day/Night Camera:
   1. Comply with UL/EN 60950-1 and UL 60950-22.
   2. Power: Power over Ethernet (PoE) IEEE 802.3af, Class 3.
   3. Video:
      a. Provide simultaneous Motion JPEG and H.264 streams
      b. Provide at least two video streams in HDTV 720p at up to 30 frames per second (60Hz mode).
      c. The H.264 implementation shall include both unicast and multicast functionality and support Constant Bit Rate (CBR) as well as Variable Bit Rate (VBR).
   4. Network functionality:
      a. IPv4 and IPv6
      b. Support both static IP addresses and addresses from a DHCP-server.
      c. Support for Quality of Service (QoS)
      d. Equipped with a RJ45 100BASE-TX Ethernet port.

5. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 2 lux at, with camera AGC off.
6. Sensitivity: Must provide images down to 0.2 lux in color and 0.04 in B/W.
7. Motion Detector: Built-in video and audio detection, with ability to provide external source input.
8. Standardization/Compatibility: Conform to ONVIF Profile S or ONVIF Version 1.01 or higher as defined by ONVIF organization and be upgradeable at any time.
9. On board storage: The camera shall support microSD/microSDHC/microSDXC, memory up to 64GB.
10. BOD Camera Models:

L. Outdoor Fixed Color Dome Camera, tamper resistant with IR Illuminator:
1. Comply with UL/EN 60950-1 and UL 60950-22.
2. Power: Power over Ethernet (PoE) IEEE 802.3af, Class 3, Max 12.1W.
3. IP 66, IP 67, NEMA 4X rated, IK09 impact resistant casing.
4. Video:
   a. Provide simultaneous Motion JPEG and H.264 streams
   b. Provide at least two video streams in HDTV 720p at up to 30 frames per second (60Hz mode).
   c. The H.264 implementation shall include both unicast and multicast functionality and support Constant Bit Rate (CBR) as well as Variable Bit Rate (VBR).
5. Network functionality:
   a. IPv4 and IPv6
   b. Support both static IP addresses and addresses from a DHCP-server.
   c. Support for Quality of Service (QoS)
   d. Equipped with a RJ45 100BASE-TX Ethernet port.
6. Impact Resistance: Meet IEC 62262 Class IK10
7. IR Illumination:
   a. Built-in IR LED’s with adjustable angle of illumination and intensity
   b. Range of 30m (100ft).
   c. Emit light with a wavelength of 850nm.
8. Motion Detector: Built-in video and audio detection, with ability to provide external source input.
9. Standardization/Compatibility: Conform to ONVIF Profile S or ONVIF Version 1.01 or higher as defined by ONVIF organization and be upgradeable at any time.
10. On board storage: The camera shall support microSD/microSDHC/microSDXC, memory up to 64GB.
11. BOD Camera Models:

2.03 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera, infrared illuminator, and lens.
1. Enclosure: NEMA 250, Type 3.

2.04 CAMERA-SUPPORTING EQUIPMENT

A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

B. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

C. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
   1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit shall identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Division 28 Section "Intrusion Detection."
   2. Duplex Receptacle: Internally mounted.
   3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
   4. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
   5. Sun shield shall not interfere with normal airflow around the housing.
   6. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
   7. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
   8. Enclosure Rating: NEMA 4 with an IP66 impact rating for outdoors, NEMA 3R for indoors.

2.05 CAMERA MOUNTS

A. Camera mount suitable to support approved cameras at the location shown on the Drawings. Complete with mounting plates, T-bar brackets, back boxes, threaded rods, adapters, slack wires, etc. to securely mount and anchor a camera to walls, ceilings and structure.

B. Refer to drawing T1.01 – Video Surveillance Camera Schedule for camera position and camera mount requirements.

2.06 CAMERA ENCLOSURES

A. Camera enclosures suitable to support approved cameras at the location shown on the Drawings. Complete with weather guards, sun shields to protect the video surveillance camera and its operation matched to perform in the associated weather condition.

2.07 NETWORK VIDEO RECORDERS

A. Owner provided / Existing.

B. Manufacturers:
1. Verkada Allegiance

C. Recording parameters:
1. Full-Featured Search Capabilities: Search based on camera, time, or date.
2. Automatic data replenishment to ensure recording even if network is down.
3. Digital certification by watermarking.
4. Compression H2.64 and H.265.
5. Resolution-Refer to camera schedule.
6. FPS: Refer to video surveillance camera schedule.
7. Hours of Activity: 24 hrs.
8. Percent of Motion: 80 percent.
9. Bitrate-Manufacture Recommended.
10. Storage Timeframe: 30 Days.
11. Video recording up to 1 Gbps for internal storage and up to 10 Gbps for external storage.
12. Duplex Operation: Simultaneous recording and playback.
13. Continuous and alarm-based recording

D. Recorder Requirements:
1. Dual Power Supplies.
2. Dual NIC cards.
3. Raid 6 configuration.
4. Storage capacity based on finalized calculation.
5. Hot swappable drives.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturers' instructions for installing components, devices, accessories, cable and for programming and adjusting the components.

B. Keep items protected before and after installation, with dust and waterproof barrier materials as necessary. Maintain the integrity of the protective measures until Owner Acceptance.

C. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

D. Protect cable and equipment from damage, at-all-times during the construction. Do not install cables and equipment in the communications rooms until the other trades have completed their work in the areas so that the equipment will not be moved or damaged. Do not install cable and equipment in communications rooms until after plywood backboards have been painted.

E. Examine conduit and back box rough-in provisions in wall, ceiling and exterior areas for video surveillance cameras. Report adverse conditions to the Architect prior to installation.

F. Provide safety slack wires from ceiling mounted devices to structure above as per applicable codes.

G. Maintain safe ingress and egress from work areas during the movement and installation. Examine the areas to receive the work and the conditions under which the Work would be performed. Remedy unsatisfactory conditions detrimental to the proper and timely completion of the Work. Where a remedy of unsatisfactory conditions is not available or possible, notify the Architect for resolution. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Obtain video surveillance camera programming templates from the Manufacturer(s). Coordinate programming parameter options with the Architect and Owner prior to programming.

B. Schedule a meeting(s) with Architect and Owner:
1. Present project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up the system and video surveillance software.
2. Confirm the exact location of cameras.
3. Confirm proposed video surveillance cameras and lenses to support camera objective.
4. Confirm video surveillance camera’s view.
5. Coordinate requirements for guard tour plans and schedules.
6. Coordinate software and license requirements and acceptance.
7. Coordinate default system and devices logins and passwords, and how they will be changed to Owner logins and passwords.
8. Coordinate storage calculations and requirements.
9. Coordinate network switch port requirements to connect video surveillance cameras into the network.
10. Coordinate network bandwidth requirements and the impact the video streaming traffic will have on the network.
11. Coordinate network access control requirements.
12. Coordinate requirements for storing video streams from the video surveillance cameras onto the Owner provided virtualized servers and recorders.
13. Coordinate installation of video storage devices in the communication rooms.

14. Coordinate video surveillance cameras network address requirements.
15. Coordinate cable and video surveillance cameras labeling nomenclature.
16. Coordinate video surveillance camera naming for video management system programming.
17. Coordinate video surveillance camera programming requirements with the Architect and Owner to include.
    a. Recording setting:
        1) Schedules for continuous recording.
        2) Frame rates.
        3) Recording rules.
        4) Storage retention.
        5) Local recording.
    b. Analytic options and settings of rules.
    c. Analytic triggers and response and system response.
    d. Analytic alert detection.
    e. Analytic alarm detection.
    f. Alarm:
        1) Recognition.
        2) Annunciation.
        3) Communication.
        4) Action response.
18. Coordinate how security staff workstations shall be set up and programmed.
19. Coordinate the interfacing of the new system components with the existing system.
20. Coordinate the unification of video surveillance cameras added to the video management system with other electronic security systems:
    a. Activation of door forced open or held open alarm associated with a video surveillance camera shall switch a video surveillance camera stream to a spot monitor at the Security Workstation.
    b. Activation of video surveillance camera license plate recognition authentication shall allow activation of parking control gate controls.
    c. Activation of infant security system door controller alarm associated with a video surveillance camera shall switch a video surveillance camera stream to a spot video display at the Security Workstation and to a video display at associated nurse stations.
    d. Activation of intrusion detection system sensor alarms associated with a video surveillance camera shall switch a video surveillance camera stream to a spot video display at the Security Workstation.
    e. Activation of video surveillance camera analytic alerts shall switch a video surveillance camera stream to a spot monitor at the Security Workstation
    f. Activation of video surveillance camera analytic alarms shall switch a video surveillance camera stream to a spot monitor at the Security Workstation.
21. Coordinate a plan for system testing, startup, and demonstration.
22. Record and share decisions for approval and acceptance by the Architect and Owner.
23. Coordinate the Work schedule and the sequence of Work.

C. Secure software and video surveillance camera licenses.

3.03 EXISTING WORK

A. Confirm with the Owner the inventory and functionality of video surveillance cameras.

3.04 EXISTING SYSTEM

A. Conduct a site visit with the Architect and Owner prior to commencement of Work.
   1. Review the build and performance of the system server(s) and network video recorders currently in use.
   2. Suggest modifications to the current system server to enhance current performance and to enhance performance of the expanded system.
   3. Review the build and performance of the video management system workstation currently in use.at the security desk.
   4. Suggest modifications to the current management workstation to enhance current performance and to enhance performance of the expanded system.
   5. Review the operation and setup of the current security desk currently in use.
   6. Suggest modifications to the current security desk to enhance current operation and to enhance operation of the expanded system.
   7. Review the operational parameters of the video management system.
   8. Review the conditions of the installed video surveillance cameras currently in use and confirm that the video surveillance cameras were properly installed.
   9. Suggest modifications to the current video surveillance camera installation that were not properly installed.

B. Perform operational tests to confirm that the video management system is properly functioning and to set a minimum base line for final system acceptance.

C. Perform operational tests to confirm that the video management system is properly integrated with other Division 28 system and to set a minimum base line for final system acceptance.

D. Confirm that the video management system database is properly backed up.

E. Update video management system to include added and replace video surveillance cameras.

F. Update video management system to the latest software release.

G. Update video surveillance cameras firmware to the latest firmware release.

H. Coordinate the interfacing of the new system components with the existing systems with the Owner prior to the commencement of any work.

3.05 INSTALLATION

A. Provide a horizontal cable termination scheduled for cable and terminations devices installed under this Work.

B. Route cables in conduits, raceway and cable trays as shown on the drawings.

C. Provide J-hooks to support the cables in accessible ceiling areas were where conduits and cable tray are not available.

D. Provide plenum rated cable in environmental airspaces, including plenum ceilings.

E. Confirm that horizontal communication cables are terminated, labeled and tested before connecting cables to camaras.

F. Provide patch cords fand equipment cords for video surveillance cameras.

G. Provide video surveillance cameras. Mount the cameras to back boxes, to associated camera mounts or to enclosures to support and position the camera for optimal viewing.

H. Provide safety slack wires from ceiling mounted cameras and devices to structure above as per Codes.

I. Provide and ground electrostatic discharge surge protectors on exterior cameras. Follow manufacturers installation requirements.

J. Provide network video recorders/servers in the Owner’s communication room.

3.06 SYSTEM PROGRAMMING

A. Load background files to show new site, buildings, floors and cameras.

B. Program the video surveillance cameras and video management system to include the new building and new video surveillance cameras:
1. Frame rate.
2. Compression.
3. Recording schedule.
4. Resolution
5. View angle.
6. Orientation.
7. Motion.
8. Alarm/alerts triggers.
9. Alarm/alert trigger action response.

C. Calibrate camera settings including:
1. Position.
2. Mount.

3. Orientation.
4. Focal length.
5. Height.
6. Tilt.
7. Roll.
8. Light level.

D. Calibrate camera settings for activation of camera and video management system analytics including:
1. Sensor size.
2. Focal length.
3. Light level.
4. Camera height
5. Field of view.
6. Angle of field of view.
7. Type of object.
8. Size of object.
9. Speed of object.
10. Direction of object travel.
11. Area of interest.
12. Audio threshold.
13. Audio spectrographs.
14. Sound classification.
15. Decision rules.
16. Alert filters.
17. Alert triggers.

3.07 LICENSES

A. Register, secure and provides licenses to the Owner to provide a fully functioning and integrated system

3.08 IDENTIFICATION

A. Label cables at each end signifying equipment location number in correspondence with the approved cable termination schedule and the Shop Drawings with machine generated self-laminating labels.

B. Label video surveillance cameras in accordance with the approved Shop Drawings with machine generated self-laminating labels.

3.09 FIRESTOPPING

A. Provide Firestopping systems as rated walls and floors where system’s cables are run.

B. Comply with requirements in Division 01, [Section [07 84 13]] "Penetration Firestopping."

C. Comply with TIA-569 "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.10 FIELD QUALITY CONTROL

A. Provide a quality control and testing and acceptance plan, and an associated schedule to the Architect and Owner, a minimum of 2 weeks before the commencement of the testing. Include tester credentials and test documentation templates.

B. Engage a qualified testing agency to perform tests and inspections

C. Receive and review horizontal cable.

D. Inspect cameras and mounts to confirm they are ready for performance testing, are secured to structure and are labeled.

E. Confirm network parameters have been coordinated with the Owner and have been set and the network is ready image transport.

F. Perform operational tests on the completed (installed and programmed) to confirm proper image capture performance and operation. Conduct tests at varying lighting levels, including day and night scenes. Confirm cameras performance meets program and video surveillance camera schedule objectives including:
1. Camera view objective.
2. Camara focus.
3. Pixel density/objective detail.
4. Image orientation.
5. Angle of view.
6. Camera pre-set positions.
7. PTZ camera pre-set positions.
8. Guard tour plan and schedule.
9. Light levels and uniformity.
10. Lighting interference.
11. Back light interference.
12. Auto-iris lens operation.
13. Image quality.
14. Recording parameters.
15. Analytic trigger objectives.
16. Analytic set points.
17. Analytic alarm/alert responses.
18. Final map view backgrounds.
19. Camera common name identification.
20. Video management system workstation programming.
21. Operation of system management station is unified with the Division 28 system identified herein.
22. System integration.

23. System database backup and recovery parameters are set.
24. System database backup.
25. Video storage prediction.

G. Report negative performance test results to the Architect for direction and resolution.

H. Prepare test and inspection reports and submit under Article “Closeout Submittals”.

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of system Owner Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two, visits to the Project site during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.12 DEMONSTRATION AND TRAINING

A. Provide a training plan to Architect and Owner in advance of commencement of the training sessions. Include trainer credentials, training schedules with quantity of classes and durations and training materials for approval by the Owner.

B. Demonstrate system operation to the Owner’s Security Staff and Facilities Engineer.

C. Conduct a walking tour of Project with the Architect and Owner to describe, demonstrate and review function, operation, maintenance and warranty of each component.

D. Provide a minimum of two, 4-hour classroom training session(s) for the Owner’s systems operators. The session shall be conducted on the Owner’s site. The sessions shall include the following.
1. Training outline, agenda and training material for (#) people.
2. System operation manuals.
3. System programming manuals.
4. Demonstrate system operations, management, features, and component programming.
5. Operating features of the video surveillance cameras and video management system,
    a. Set up.
    b. Camera set up and naming.
    c. Analytic functions.

d. Alert/alarm identification.
e. Video management system list view and map view assignment.
f. Integration with the:
g. Physical Identity & Access Management System.

E. Provide a video recorder and record the training sessions. Provide to Owner 2, copies of the training sessions on a USB and digital video.

F. Use submitted operation and maintenance manual as reference during demonstration and training.

3.13 OPERATION AND MAINTENANCE MANUALS

A. Provide product, user and operation manuals provided by the manufacturer to contain the following.
1. Preventive maintenance program.
2. Service instructions for components of the system as a whole and each component, function and operation in detail.
3. Illustrations, mounting instructions, wiring diagrams, parts lists, operating instructions and a trouble-shooting chart for the system, including a list of troubles, causes and recommended remedies. Include wiring diagram showing all components.

B. Manuals shall be written to aid in training of new security and operating personnel and as guide clarifying operational procedures.

C. Spare Parts List. Submit list of spare parts and components of critical items for consideration of purchase by Owner.

3.14 MAINTENANCE AND SERVICE

A. General Requirements: Provide services, materials, and equipment necessary for the successful operation of the system for a period of one year after completion of acceptance testing, the completion of system commissioning, Owner acceptance. Provide necessary material required for the Work. Minimize impacts on facility operations when performing scheduled adjustments and nonscheduled Work.]

B. Description of Work: The adjustment and repair of the system includes computer equipment, software updates, transmission equipment, card readers and control devices. Provide the manufacturer's required adjustments and Work.

3.15 WARRANTY

A. Register and provide proof-of-purchases required to activate Manufacturer’s warranty.

B. The warranty shall include labor and equipment to maintain the integrated system in full operation for a period of one year for hardware from the date of Owner acceptance.

C. The warranty shall provide:
   1. A contact number for service call during the warranty period that is answered 24 hours 7 days a week. Service calls made outside of normal working hours and received by an answering service shall be returned within 1 hour.
   2. Standard on-site service calls within 12 hours.
   3. Emergency on-site service calls within 4 hrs.
   4. The end-user will notify the contractor of the appropriate response time required. This warranty may be enhanced by the contractor but cannot be taken away from this supersedes all other warranties.

D. Invoke manufacturer's warranties as necessary during the warranty period. Obtain Return-Merchandise-Authorization for shipping defective material back and receiving replacements materials.

3.16 CLEANING

A. Clean system components, including camara lenses, camera-housing windows, lenses, and monitor screens. using methods and materials recommended in writing by manufacturer

END OF SECTION

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fire alarm system shall consist of fire alarm control panel, of the same make and CSFM (California State Fire Marshal) listed for the application.

B. Labor, equipment, materials, connections, testing, and performance of operations in the installation of fire alarm system

1.02 RELATED DOCUMENTS

A. Division 01 – General Requirements

B. Division 23 – Mechanical Systems

C. Section 26 00 00 – Electrical

1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.

B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years' experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.

C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

1.04 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Projected Beam smoke detectors.

5. Heat detectors.
6. Notification appliances.
7. Device guards.
8. Magnetic door holders.
9. Remote annunciator.
10. Addressable interface device.
11. Network communications.

1.05 REFERENCES

A. 2019 - ASME A17.1 – Safety Code for Elevators and Escalators

B. 2020 - NFPA 70 – National Electrical Code

C. 2022 - NFPA 72 – National Fire Alarm and Signaling Code

D. 2022 - California Fire Code (CFC)

E. 2022 - California Building Code (CBC)

F. 2022 - California Mechanical Code (CMC)

G. 2016 - UL 268, Smoke Detectors for Fire Protection Signaling Systems

H. 2009 - UL 268A, Smoke Detectors for Duct Application.

I. 2003 - UL 464, Audible Signal Appliances

J. 2014 - UL 864, Fire Alarm

K. 2006 - UL 1481, Power Supplies for Fire Protection Signaling Systems

L. 2018 - UL 1971 Signaling Devices for Hearing Impaired

M. 2016 - UL 2017, General Signaling

1.06 DEFINITIONS

A. CSFM: California State Fire Marshal

B. DSA: Department of State Architects

C. EMT: Electrical Metallic Tubing.

D. FACP: Fire Alarm Control Panel.

E. HLI: High Level Interface.

F. NICET: National Institute for Certification in Engineering Technologies.

G. PC: Personal computer.

H. UL: Underwriters Laboratory

1.07 SUBMITTALS

A. Product Catalog Data Sheets:

1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings but required for the operation of the system.
2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
4. In addition to the above requirements, provide submittals to meet any additional requirements of the DSA.

B. Shop Drawings:

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Provide the following: manufacturer’s wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
3. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
4. Voice Alarm Communication System: Submit equipment rack or console layout, grounding schematic, amplifier power calculations, and wiring diagram.
5. Include plans, elevations, sections, details, and attachments to other work as necessary.
6. Include input/output matrix.
7. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by DSA.
2. System shall be UL or FM listed.
3. System shall be CSFM listed.
4. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified, fire-alarm technician; Level III minimum.

1.08 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, voice evacuation equipment, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.

C. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog- addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.

D. Campus Network: A complete fire alarm Copper connection shall be provided. Monitoring of new fire alarm system since a different manufacturer for the fire alarm panel is being installed. The new fire alarm control panel will only provide alarm, trouble and supervisory signals to the campus main panel via relays. Three (3) new monitor modules will be provided from the existing fire alarm campus panel.

E. Voice Communication: The facility shall have an emergency voice alarm communication system. The digitized recorded voice message shall notify occupants that a fire condition has been reported. Emergency manual voice override shall be provided.

F. Emergency Communication System (ECS): A system capable of reproduction of prerecorded, synthesized, or live messages with voice intelligibility to indicate the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action.

G. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.

H. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.

I. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.

J. Fire alarm systems and components shall be of the latest technology.

1. The model shall be the latest version put out by the manufacturer.
2. Parts must be readily available for five (5) years.
3. System shall be supported by the manufacturer for five (5) years.

K. System must have the capability to be viewed remotely. The remote viewing shall be Web based.

L. Any contractor that modifies the fire alarm system database takes full responsibility for the entire fire alarm system database.

1.09 OPERATION AND MAINTENANCE DATA

A. Include operating instructions, and maintenance and repair procedures.

B. Include results of testing of all devices and functions.

C. Include manufacturer’s representative's letter stating that system is operational.

D. Include the CAD floor plan drawings.

E. Include shop drawings as reviewed by the Architect/Engineer and DSA.

1.10 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified for "Operation and Maintenance Data," include the following:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.

f. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.11 DOCUMENT STORAGE CABINET

A. The cabinet shall have all fire alarm system documents, including record drawings, wiring diagrams, operation manuals, etc. A legend sheet permanently attached to the door shall contain system passwords and inspection logs. The enclosure shall also provide two (2) key ring holders for system keys and a location for a standard-sized business card with service contact information. The cabinet will have, permanently and securely mounted inside, a digital flash memory device with a minimum of 4 GB of storage capacity and a standard USB B connector for uploading and downloading electronic versions of record documents and system programming information.

B. The cabinet shall be red in color with an identification label reading “FIRE ALARM DOCUMENTS”. The cabinet shall be lockable.

C. The final version of the system database program shall be stored within the cabinet.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.

    a. Smoke and heat detectors, manual fire alarm box, monitor modules, control modules and relays.
    b. Notification appliances: Speakers, speaker strobes, and strobes.
    c. In addition to the above, an additional 5% of component parts shall be provided as added stock.

2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet [minimum of one (1) set each] and shall turn over to the Owner upon completion.
3. All spare parts shall be housed in metal cabinet labeled “Fire Alarm Spare Parts”.
4. Trouble shooting and cleaning kits shall be provided.

1.13 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. Installer shall furnish a letter from manufacturer of equipment certifying equipment has been installed according to factory standards and that system is operating properly.

D. Certifications: Installer shall submit certification from the equipment manufacturer indicating that installer is an authorized representative of the equipment manufacturer, is trained on network applications.

E. Materials and equipment installed shall be new.

F. At the time of installation, the most current software package available shall be provided.

G. System startup and testing shall be performed under the direct observation of the Project Inspector and Owner Authorized Representative (OAR). Provide a legible half size reproduction of the original completed fire alarm red-line drawings (this copy will be retained by the Owner), an accurate copy of the fire alarm system points list, and a copy of the construction drawings on CD in AutoCAD format.

H. Provide a backup copy of the most current software revision, in disk format. This copy shall be delivered to the OAR.

1.14 RECORD DOCUMENTS

A. Include location of end-of-line devices.

B. Provide a CAD drawing of each area of the building (minimum scale of 1/16” = 1’-0”) showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.

C. Contractor shall develop and submit a campus map showing the entire system, including the location of all devices.

D. Contractor shall provide a list of the location of all devices. In addition, all fire alarm devices shall be tagged.

E. System be integrated with school drawings and match current room number signage.

F. Copies of the video training shall be supplied.

G. The Fire Alarm System must pass commissioning prior to acceptance.

H. Four (4) hours of in-person training shall be provided.

1.15 ANNUAL INSPECTION/TESTING AND SERVICE CONTRACT

A. Provide cost to furnish service, inspect, and test all devices of the fire alarm system per the requirement of NFPA for one (1) year, starting one year after the Date of Substantial Completion. Submit written reports of inspection testing per NFPA 72, Chapter 14.

B. Provide an alternate cost for a complete inspection/testing and service/maintenance contract for the fire alarm system for one (1) year two (2) years, starting one year after the Date of Substantial Completion. Submit sample contract terms and conditions for review with shop drawings.

C. The Owner may enter into a contract directly with the vendor after shop drawing submittals. This specification is not a contract between the Owner and the vendor to perform these services.

1.16 WARRANTY

A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.

B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. Silent Knight.

B. Source Limitations for Fire-Alarm System and Components: Components shall be compatible and provided with and operate as an extension to existing Campus main fire alarm panel.

2.02 SYSTEM DESCRIPTION

A. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL certified and CSFM approved addressable system, with multiplexed signal transmission and voice/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual fire alarm box.
2. Heat detectors.
3. Smoke detectors.
4. Projected beam smoke detector.
5. Automatic sprinkler system waterflow.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels and remote annunciator.
3. Transmit an alarm signal to the main campus fire alarm control panel via relay which is then sent via AES wireless transmitter to central station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.

6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. User disabling of zones or individual devices.
3. Fire pump running
4. Fire pump loss of power
5. Fire pump power phase reversal
6. Loss of communication with any panel on the network.
7. Transmit a supervisory signal to the main campus fire alarm control panel via relay which is then sent via AES wireless transmitter to central station.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Transmit a trouble signal to the main campus fire alarm control panel via relay which is then sent via AES wireless transmitter to central station.

E. System Supervisory Signal Actions:

1. Identify specific device initiating the event at fire-alarm control panel and remote annunciator.
2. Transmit a supervisory signal to the main campus fire alarm control panel via relay which is then sent via AES wireless transmitter to central station.

2.04 FIRE-ALARM CONTROL UNIT

A. Silent Knight

B. General Requirements for Fire-Alarm Control Unit (FACU):

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
    c. Include a real-time clock for time annotation of events on the event recorder.
    d. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.
    e. Provide communication between the FACU and remote circuit interface panels, annunciators, and displays.
    f. All power for the unit shall be supervised and supplied by the FAP.
    g. The FACU shall be listed for connection to a central station signaling system service.
    h. The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.
    i. Serial Interface Board: The board shall provide interfaces to a printer, LCD display and other monitoring devices through RS-232 connections. The minimum operational distance between the board and the peripheral devices shall be 500 feet. Up to three (3) RS-232 outputs shall be supported.

2. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:

Minimum Total Addressable Points:	250	500	2000			
Minimum Total SLC loops (including Board, ready for field connections):	1	2	4	6	8	10
Panel Expansion Capacity, Minimum	10 Total SLC loops:					
Minimum Node capacity for Network	100 Systems:					

3. Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC) Boards:

    a. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions.

Analog signals would be used for automatic test and determination of maintenance requirements.

b. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.

C. Interconnection of Multiple Fire Alarm Panels:

1. The pathways of interconnected fire alarm panels or systems shall be as follows:

2. Pathway Class X: Circuits with redundant pathways capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor wiring system. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a two-hour rated enclosure.

3. Fire Alarm System shall be connected to the central panel.

   a. System must register on the main panel.

4. System shall be installed with a copper network.

5. Building must be integrated into the existing main high school campus system via relays for the monitoring of an alarm, trouble and supervisory signal. Three (3) monitor modules shall be provided from the existing campus fire alarm control panel for the monitoring of these points.

D. Display.

1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.
3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.
4. The board shall provide a touch keypad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Pathway Survivability: Level 0.
3. Serial Interfaces: (if applicable)

a. One dedicated RS 485 port for remote station operation using point ID DACT.
b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
c. One RS 323 port for PC configuration.
d. One RS 232 port for voice evacuation interface.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Notification appliances shall provide an alarm signal 15 dB above the average ambient sound level or 5 dB above the maximum sound level, and/or at least 75 dBA.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

J. Power Supply:

1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated emergency branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements.
2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.
3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.
4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours

in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.

K. Surge Protection:

1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 26 05 53. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.
2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

L. Digitized Voice Command Center (VCC):

1. The Digitized Voice Command Center (VCC) shall contain all equipment required for all audio control, signaling, and supervisory functions. This shall include digital voice units and microphones.
2. The Voice Command Center equipment shall perform the following functions:

    a. Operate as a supervised single channel automatic digitized voice evacuation system with manual emergency voice communication system.
    b. Audibly and visually annunciate the active or trouble condition of every signal circuit.
    c. Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.
    d. Provide all-call activities through activation of a single control switch.
    e. Provide automatic, digitally recorded voice messages and tones.

3. Audio Amplifiers:

    a. The audio amplifiers will provide a single channel audio power at 25/70 volts RMS for distribution to speaker circuits.
    b. Provide multiple audio amplifiers mounted in the main fire alarm control panel, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
    c. The audio amplifier shall include an integral power supply, and shall provide the following controls and indicators:

        1) Normal Audio Level LED
        2) Incorrect Audio Level LED
        3) Battery Trouble LED
        4) Amplifier Trouble LED
        5) Audio Amplifier Gain Adjust.

    d. Includes audio input and amplified output supervision backup input.

4. Audio Message Generator (Digitized Voice):

   a. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a digitized voice message to all speakers in the building.
   b. Actuation of any alarm initiating device shall cause a digitized message to sound over the speakers. The message shall be repeated four (4) times.
   c. A built-in microphone shall be provided to allow paging through speaker circuits.
   d. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control:

      1) All Call LED
      2) On-Line LED
      3) All Call Switch

5. Voice Messages:

   a. A pre-programmed custom digital voice message shall be used for notification appliance speaker circuits. The messages shall be approved by the Authority Having Jurisdiction (AHJ). Voice messages shall be from a male voice.

   b. Message shall be preceded by a tone and message shall be repeated four times until silenced.

   c. Messages shall be annunciated by a single channel in all evacuation signal zones throughout the building.

   d. Message shall be as shown in the following table. These messages are not intended to specify the exact wording required, but to specify the minimum information conveyed by the message:

Alarm Type	NAC Area	Preceding Tone	Message
Fire Alarm	Single Channel-all areas	Three Chimes	May I have your attention please? A fire emergency has been reported in the building. Proceed calmly to the nearest exit and leave the building immediately.
Test	All areas	One Chime	“May I have your attention please? May I have your attention please? This is a test of the building emergency alarm system. This is only a

			test."
All Clear	All areas	One Chime	"May I have your attention please? May I have your attention please? The reported emergency has been investigated and normal conditions have been restored. You may re-turn to all areas of the building."

6. Speaker Circuit Control Switches/Indicators:

   a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
   b. The speaker circuit control panel shall include switches to manually activate or de-activate each speaker circuit in the system.

2.05 MANUAL FIRE ALARM BOXES

A. Silent Knight.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

C. Manual fire alarm boxes shall match the description on the drawings symbol legend. The station shall be mounted where shown on the drawings and be provided with all necessary mounting hardware. Use surface mount only on precast concrete or structure.

D. Addressable, double action with plastic break rod, reset key lock, semi-flush mount, red high abuse plastic construction with white lettering.

E. Manual fire alarm boxes shall connect directly to an SLC loop.

2.06 SYSTEM SMOKE DETECTORS

A. Silent Knight.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.

2. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power on status.
6. Each smoke detector shall connect directly to an SLC loop.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by the fire-alarm control unit.
8. Where operation is noted as required below 32ºF and/or above 120ºF, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32ºF and 120ºF.
9. A subscript is used to identify the device with a specific sequence of operation as follows: D=HVAC Control, SW=Stairwell, CR=Computer Room, SD=Smoke Dampers, DH=Door Hold Release.
10. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
11. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

2.07 PROJECTED BEAM SMOKE DETECTORS

A. Projected Beam Light Source/Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.

B. This device shall utilize photoelectric analog smoke sensor technology. Provide with transmitter and reflector. Microprocessor-based detector shall provide a minimum of eight sensitivity levels, temperature and dirt compensation, and automatic gain control. Sensor to contain beam alignment adjustments and receiver calibration.

C. Detector shall be provided with multiple monitor modules, as required, to connect to the SLC loop and for monitoring alarm and trouble output contacts. The detector shall be provided complete with all mounting hardware provided and installed where indicated on the drawings.

D. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.

E. Provide with remote test/indicator panel providing LED indications of alarm and trouble.

F. For system projected beam smoke detectors (if addressable), an operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

1. Primary status.
2. Device type.
3. Present average value.
4. Present sensitivity selected.
5. Sensor range (normal, dirty, etc.).

2.08 HEAT DETECTORS

A. Silent Knight.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135ºF and at 15ºF per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area.

2.09 NOTIFICATION APPLIANCES

A. System Sensor – SpectrAlert.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Device Color:

1. Wall Mounted: White housing with red lettering.

2. Ceiling Mounted: White housing with red lettering.

D. Visible Notification Appliances: strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field.

2. Candela rating shall be visible from exterior of the device.
3. Candela rating shall be visible from exterior of the device
4. Mounting: Wall mounted unless otherwise indicated.
5. Flashing shall be in a temporal pattern, synchronized with other units.
6. Strobe Leads: Factory connected to screw terminals.
7. Mounting Faceplate: Factory finished, white.
8. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

E. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1/4 to 2 W.
5. Sound rating shall be dependent on the tap (wattage) setting.
6. Tap settings shall be available in 3 dBA increments.
7. A minimum of four (4) tap settings should be available to allow field adjustment of the sound output across a minimum range of 78 to 87 dBA, 400Hz to 4KHz (6 dBA cutoff) frequency range
8. Mounting: Flush, and surface.
9. Matching Transformers: Tap range matched to acoustical environment of speaker location.
10. Speakers shall clearly reproduce a signal consisting of a live or prerecorded human voice with voice intelligibility.
11. Speaker, housing, and backbox shall be UL listed for fire alarm/emergency applications.

F. Combination Audio (Voice) and Visual Notification Device:

1. Combine speaker and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.

G. Weatherproof Visual Notification Device:

1. High intensity strobe, square housing, 75 candela rating, suitable for wet locations. Provide with weatherproof back box.
2. Mounting: Semi-flush wall.
3. Conduit shall not be exposed.

H. Weatherproof Voice/Visual Notification Device:

1. Speaker with high intensity 75 candela rated strobe. A minimum of four (4) tap settings which shall allow field adjustment of the sound output across a minimum range of 78 to 87 dBA (UL 1480), 400 Hz to 4 KHz (6dBA cutoff) frequency range.
2. Mounting: Semi-flush wall.
3. Conduit shall not be exposed.

2.10 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.11 REMOTE POWER SUPPLIES (RPS)

A. Silent Knight.

B. As shown on the plans furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC).

C. Each RPS shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each RPS provides a minimum of up to 4 outputs, 2A continuous, or 10A full load total capacity.

D. Power for each RPS shall be from a local 120 VAC emergency circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NEP from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer’s standard handle lock-on device.

E. Mounting: Surface.

2.12 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

2. Communications and power to the annunciators shall be supervised. The annunciator shall receive power from the fire alarm control panel.
3. Minimum 80-character display.
4. A single key switch shall enable all switches on the annunciator.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.13 ADDRESSABLE INTERFACE DEVICE

A. Monitor Modules:

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
3. Store an internal identifying code for control panel use to identify the module type.
4. Listed for controlling HVAC fan motor controllers.
5. Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts

B. Addressable Relays:

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.
2. Allow the control panel to switch the relay contacts on command.
3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.

4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

C. Control Modules:

1. Operate notification appliances.

2.14 ETHERNET NETWORK COMMUNICATIONS (If applicable)

A. School Ethernet IP Network: A complete fire alarm Ethernet network shall be provided. The network shall be Class X wiring, Resilient Ethernet Protocol (REP) 100BaseTX / 100 Mbps that shall be able to operate with any single break and restore network communications.

B. The IP network shall be fiber optic cable, single or multi-mode fiber. The TCP/IP network switches shall be industrial grade managed switching hubs. Network switches shall be UL864 listed, shall provide a minimum of four (4) or a maximum of eight (8) 10/100 Mbps shielded RF-45 connectors for Ethernet connections, and selectable multi-mode or single- mode fiber ports. The switches shall operate on a nominal 24 VDC supplied from a battery backed up fire alarm control panel or booster power supply to ensure power to the switch is always available. Switches shall provide LED indicators for data rate, activity/link integrity, power, and loop detection.

C. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

D. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

E. Provide integration gateway using BACnet for connection to building automation system.

2.15 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS (if applicable)

A. Smoke Damper: Motorized type, 120 VAC, furnished and installed by Mechanical Contractor (MC). Fire alarm control and power connections by Electrical Contractor (EC). A subscript is used to identify the device with a specific air handler or zone for its sequence of operation.

B. Smoke or Fire/Smoke Damper Controller: Provide an enclosure and equipment for interface of dampers with the fire alarm system and temperature control system.

C. Flow Switch: Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.

D. Monitor Switch: Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.

E. Post Indicator Valve/Double Check Valve: Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.

F. Electronic Bell: Electronic bell for sprinkler alarm, electro-mechanical type, 24Vdc. Furnished and installed by FAC. Fire alarm control and power connections by EC.

2.16 DEVICE GUARDS (if applicable)

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

2.17 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer’s recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.

B. All network wiring shall be copper or fiber and installed in conduit.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SYSTEM INSTALLATION

A. Install required conductors to devices indicated on Drawings. Provide required conductor terminations to devices for a complete system to function as specified and indicated on Drawings.

B. Splices are not allowed in junction boxes. Terminations shall be in terminal cabinets or on equipment terminals. Wire-nuts are not acceptable; all splices shall be made on terminal strips.

C. Conductors shall be installed within conduits, boxes, and terminal cabinets in a totally enclosed installation. Furnish and install conductors required to connect incoming and outgoing circuits, including spare conductors, to terminal strips within terminal cabinets.

D. Wiring within equipment and terminal cabinets shall be installed to conform to contract documentation and NFPA 72 standards and shall be terminated on terminal blocks having terminals for required connections. Wiring shall be cabled, laced, and securely fastened in place so that no weight is imposed on equipment or terminals.

E. Install required terminal blocks within terminal cabinets. Terminal blocks shall be installed on inside back of cabinets only, not on side. Incoming wiring shall be terminated on the left side of terminal blocks; outgoing wiring shall be terminated on the right side of the terminal blocks.

F. Conductors shall be color-coded wires and tagged with code markers at terminal cabinets, and equipment. A wire index shall be typed and installed on terminal cabinet doors. Index shall be covered with clear plastic adhesive covers. Wiring shall be identified as to building and location of devices in the index.

G. Wiring within equipment and terminal cabinets shall be carefully strapped and shall be formed in rectangular configuration. Wires shall be properly numbered in numerical order and shall maintain same number throughout the Project site.

H. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

I. Connecting to Existing Equipment: Verify that the existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing monitoring equipment at the supervising station.

2. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

J. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48 "Seismic Controls for Communications Systems."

K. Manual Fire-Alarm Boxes:

1. Mount manual fire-alarm box on a background of a contrasting color.
2. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

L. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 36 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

M. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

N. Remote Test and Alarm Indicator: Install in a visible location near the projected beam.

O. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

P. Visible Alarm-Indicating Devices: Install at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

Q. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.03 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.04 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements for "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Supervisory connections at valve supervisory switches.
5. A/V equipment shutdown.

3.05 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 27 05 53 "Identification and Administration."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.06 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.07 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by DSA IOR.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.08 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.09 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two (2) years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 28 31 11

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Removal of vegetation, grass, grass roots, shrubs, tree stumps, trees, upturned stumps, weed growth, tree roots, brush, masonry, concrete, rubbish, debris and other materials.

2. Removal of concrete and bituminous surfaces.

3. Removal of existing fences and gates.

B. Related Requirements:

1. Division 01 - General Requirements.

2. Section 31 2200 - Grading.

3. Section 31 2313 - Excavation and Fill.

4. Section 31 2316 - Excavation and Fill for Pavement.

5. Section 31 2319 - Excavation and Fill for Structures.

6. Section 31 2323 - Excavation and Fill for Utilities.

7. Section 31 2326 - Base Course.

8. Section 32 3113 - Chain Link Fences and Gates.

9. Section 32 9000 - Planting.

1.02 SUBMITTALS

A. Shop Drawings: Submit site plan indicating extent of site clearing.

1.03 QUALITY ASSURANCE

A. Comply with Standard Specifications for Public Works Construction, current edition, as a minimum requirement.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 TREE AND STUMP REMOVAL

A. Remove trees and stumps indicated or required to be removed. Remove trees, together with bulk of roots, to a minimum depth of 4 feet below required grade, and within a radius of approximately 7 feet beyond perimeter of trunk at grade.

B. Fill and compact excavation from tree and stump removal. Fill in 6 inch layers, each compacted to 90 percent of maximum density in accordance with ASTM D1557.

1. Back filling shall not commence until the excavation is inspected and tested.

3.02 CONCRETE AND BITUMINOUS SURFACING REMOVAL

A. Break up and completely remove existing concrete surfacing, curbs, gutters, walks and bituminous surfacing to indicated limits. Cutting shall be performed to a neat and even line with proper tools or a concrete cutting saw. Minimum depth of cut shall be 1 1/2-inch, unless otherwise indicated. Remove concrete broken beyond the indicated limits to the nearest joint or score line and replace with new concrete to match existing.

3.03 FENCING

A. Existing fences scheduled to remain may be removed to facilitate the Work, provided they are installed to their original condition in accordance with requirements of Section 32 3113 - Chain Link Fences and Gates.

B. Fencing indicated to be removed and not reinstalled shall be completely removed, including footings. Fill and compact excavations.

C. Install chain link fencing indicated to be relocated or reset in accordance with applicable requirements specified under Section 32 3113 - Chain Link Fences and Gates.

3.04 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 31 22 00 - GRADING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General exterior grading, cutting and filling, including grading for building area, paving, planting areas, banks and hillsides.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 1000 - Site Clearing.
3. Section 31 2313 - Excavation and Fill.
4. Section 31 2316 - Excavation and Fill for Pavement.
5. Section 31 2319 - Excavation and Fill for Structures.
6. Section 31 2323 - Excavation and Fill for Utilities.
7. Section 31 2326 - Base Course.
8. Section 32 9000 - Planting.

1.02 PROJECT REQUIREMENTS

A. General:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.
4. Before grading, contact Underground Service Alert of Southern California (USASC) for information on public buried utilities and pipelines. Retain the services of an underground utility locator for on-site utilities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall conform to requirements specified in this and related sections.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain installed stakes until their removal is required for the Work. Provide replacement grade or location stakes lost or disturbed.

B. Install grade stakes and compare to indicated grades. If discrepancies are found between existing grades and grades indicated on Drawings, do not proceed until discrepancies are resolved.

3.02 ROUGH AND FINE GRADING

A. Rough grade area sufficiently high to require cutting by fine grading:

1. Grade area for bituminous surfacing and other paving to the indicated grades, equal to the section of the indicated base and pavement.

2. Slope banks to required finish grades as cut progresses or leave cuts full and finish grade by mechanical equipment to provide grades and soil densities indicated on the Drawings.

3. Rough grade, fill and compact banks beyond indicated finish grades. Finish grade banks and slopes to indicated grades and specified soil densities.

4. Grade Only Areas: In areas not indicated to receive pavement, rough grade to approximate finish grades and then scarify, moisten and roll to obtain required density and indicated finish grades.

5. Tolerances: Finish grades shall be within a tolerance of 0.05 inch per foot above or below grades indicated. Provide an average grade as indicated.

B. Base or Subgrade:

1. After subgrade has been constructed to approximate required grades, scarify to a depth of at least 6 inches:

a. After scarifying, process loosened material to a finely divided condition and adjust moisture content to optimum condition by addition of water, addition and blending of dry suitable material, or by drying of existing material.

b. Subgrade material shall be compacted by tamping, sheepsfoot rollers or pneumatic tire rollers. Required relative compaction shall be [**90**] percent minimum for the top 6 inches below subgrade.

c. Install base course in accordance with Section 31 2326 - Base Course.

2. Tolerance of completed grades of base or subgrade shall not vary more than 0.03 inch per foot from grades indicated. Provide an average grade as indicated.

3.03 SHORING

A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.

B. Design and Calculations: Provide in accordance with requirement of CalOHSA.

C. Remove shoring upon completion of the Work of this section or when no longer needed unless required otherwise by authorities having jurisdiction.

3.04 EXCESS MATERIAL DISPOSAL

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.05 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 31 22 19 - LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. General: This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work for Finished Grading in Landscape Planting Areas, as shown in the Contract Drawings, and as specified herein this Section.

B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following;
   1. Finish Grading of Landscape Planting Areas.

1.2 SITE CONDITIONS

A. Dust Nuisance: Contractor shall assume full responsibility for alleviation or prevention of dust as a result of Work under this Section.

B. Excessive rock, dead or declining vegetation, trash, debris, or other items that has accumulated shall be removed from the Project Site by the Contractor, and as directed by the Landscape Architect, prior to completion of Finish Grading operations.

C. Work under this Section shall be performed only during the period when beneficial and optimum Landscape Grading results may be obtained. If the moisture content of the soil should reach such a level that working it would destroy soil structure or cause compaction. Landscape Grading operations shall be suspended until, in the opinion of the Landscape Architect, the moisture content is increased or reduced to acceptable levels and the desired results are likely to be obtained.

D. Soil moisture level prior to Landscape Grading shall be no less than 75% of field capacity. The determination of adequate soil moisture for Landscape Grading shall be in the sole judgment of the Landscape Architect.

1.3 QUALITY ASSURANCE AND CONTROL

A. Installer Qualifications:
   1. Valid California C-27 (Landscaping Contractor) License.

B. Engage a 10 year experienced, licensed Contractor who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

C. Installer's Field Supervision: Contractor shall maintain an experienced, full-time landscape supervisor/superintendent at the Project site during times that landscaping operations identified herein the Contract are in progress.

1.4 COORDINATION, SCHEDULING AND OBSERVATIONS

A. Complete Finish Grading prior to installation of Irrigation system (Refer to Section 328400 – Landscape Irrigation) in each area graded.

B. Re-grade, as required, to acceptable landscape Grades established by Landscape Architect once irrigation system is installed.

C. Utilities: Determine location of above grade and underground utilities and perform Work in a manner which will avoid damage to utilities. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.

D. Excavation: When conditions detrimental to adequate Finish Grading operations are encountered, such as rubble fill, adverse drainage conditions, or obstructions, cease operations and notify Landscape Architect for further direction.

E. Perform Finish Grading operations only when weather and soil conditions are suitable in accordance with locally accepted practices.

F. Construction Site Observations: Periodic site observations shall be made by the Landscape Architect during the installation of Work under this Section for compliance with requirements. Landscape Architect retains right to observe Work for defects and to reject unsatisfactory or defective work under this Section at any time during progress of Work. The Contractor shall request, in writing, at least one (1) week in advance of the time when mandatory site observation(s) by the Landscape Architect are required.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that the following items have been completed prior to commencement of Landscape Grading:
   1. Installation of (stockpiled) topsoil and soil preparation, including debris removal.

2. Incorporation of soil amendments.

3.2 INSTALLATION

A. Finish Grading:

1. Provide Finish Grades for natural runoff of water without low spots or pockets. Accurately set flow line grades at a two-percent (2%) minimum gradient, unless otherwise noted in the Contract Drawings.
2. Finish Grades shall be smooth, even, and on a uniform plane with no abrupt changes, pits, or undulations of the surface. Slope grades uniformly between given spot elevations.
3. Finish grades not otherwise indicted shall be uniform levels or slopes between points where elevations are given, or between points established by walks, paving, curbs or catch basins.
4. Tops and toes of slopes shall be gently rounded or feathered to produce a gradual and natural-appearing transition between relatively level areas and slopes, per the satisfaction of the Landscape Architect.

B. Tolerances:

1. Planting areas, including areas planted with turf grasses. Shall be true to grade within one-inch (1”) when tested with a ten-foot (10’) straightedge.
2. Hold Finish Grades in landscape planting areas below top of adjacent pavement, headers, curbs, or walls 9where applicable), as follows:
   a. Shrub, Annual and Groundcover Areas: One and one-half inches (1-1/2”).

END OF SECTION

SECTION 31 23 13 - EXCAVATION AND FILL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavating, filling, backfilling, and compacting for Project site pavement, planting areas, buildings, and other structures.

2. Trenches for utility lines such as water, gas, irrigation, storm drain and sewer lines, concrete-encased conduits, manholes, vaults, valve boxes, catch basins, underground tanks, thrust blocks, yard boxes, pull boxes, and other utility appurtenances.

B. Related Requirements:

1. Division 01 - General Requirements.

2. Section 01 4524 - Environmental Import/Export Materials Testing.

3. Section 31 1000 - Site Clearing.

4. Section 31 2200 - Grading.

5. Section 31 2326 - Base Course.

6. Section 32 0117 - Pavement Repair.

7. Section 32 1313 - Site Concrete Work.

8. Section 32 3113 - Chain Link Fences and Gates.

9. Section 32 8413 - Potable Water Irrigation.

10. Section 32 8426 - Reclaimed Water Irrigation.

11. Section 32 9000 - Planting.

12. Section 33 1100 - Site Water Distribution Utilities.

13. Section 33 3000 - Site Sanitary Sewer Utilities.

14. Section 33 4000 - Storm Drainage Utilities.

15. Division 22 - Plumbing.

16. Division 26 - Electrical.

1.02 PROJECT REQUIREMENTS

A. Import and Export of Earth Materials:

1. Fees: Pay as required by authorities having jurisdiction over the area.

2. Bonds: Post as required by authorities having jurisdiction over the area.

3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

1.03 SUBMITTALS

A. Shoring calculations as required in Article 3.03 of this Section.

1.04 QUALITY ASSURANCE

A. Comply with the Standard Specifications for Public Works Construction, current edition, except as modified herein.

B. Sampling, testing, and certification of imported and exported soils shall be performed in accordance with Section 01 4524, Environmental Import/Export Materials Testing.

1.05 TESTING

A. OWNER will retain a Geotechnical Engineer as an OWNER Consultant who will provide observations, tests, inspections and approvals identified in the Contract Documents as being responsibility of OWNER.

B. Imported Soils: The Geotechnical Engineer will obtain initial product Sample for testing in accordance Article 3.05 of this Section.

1.05 PROJECT CONDITIONS

A. Information on Drawings or in soil investigation report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

PART 2 - PRODUCTS

2.01 FILL AND BACKFILL MATERIALS

A. Fill and backfill material shall be a granular material previously removed from excavation or imported fill material, free of clods and stones larger than 3 inches, (2½ inches for utility trenches) foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.

B. Fill material exhibiting a wide variation in consistency and moisture content shall be blended and aerated to stabilize and upgrade the material.

C. Bedding material from trench bottom to one foot above the pipe:

1. Sand, gravel, crushed aggregate or native free-draining granular material providing a sand equivalent of at least 30 or a coefficient of permeability greater than 1.4 inches per hour.

2. Sand complying with the Specifications for cement concrete aggregates.

D. Brick rubble and broken concrete originating from the Project site shall be legally disposed of off the Project site No such material shall be imported from outside the Project site.

E. Permeable Backfill:

1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:

Sieve Size:	Percentage Passing:
3/4 inch (19mm)	100
3/8 inch (10mm)	80 to 100
No. 100	0 to 8
No. 200	0 to 3

2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.

3. Provided backing for weep-holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.

4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system Miradrain by Mirafi, Inc., American Wick Drain, JDR Enterprises, or equal, may be provided if reviewed and approved by the ARCHITECT.

F. Cement-sand slurry shall be provided with one sack of cement per cubic yard of the mixture.

2.02 BASE MATERIALS

A. Concrete Slabs on Grade: Provide "Crushed Aggregate Base" as specified in Standard Specifications for Public Works Construction, Section 200 - Rock Materials, with 3/4 inch maximum size aggregates. Provide 3 inch thick base, unless noted otherwise.

B. Bituminous Surfacing: Provide as indicated on Drawings and specified in Section 31 2326 Base Course.

PART 3 - EXECUTION

3.01 GENERAL

A. Before initiating intrusive activities, contact Underground Service Alert of Southern California (USA or Dig Alert) to obtain a Dig Alert ticket for location information on buried public and USA member utilities and pipelines at least 48-hours prior to beginning work. A copy of the Dig Alert ticket shall be forwarded to the OWNER. For on-site utilities, retain a state-licensed third party underground utility locating service.

B. Where the Work includes a building extension or addition on an occupied Project site, perform Work in such a manner, and at such times, as not to disrupt performance of existing utility services to existing Project site facilities. Where an interruption is necessary, obtain review from the OAR before proceeding.

C. Remove concrete or bituminous pavement to straight lines by saw cutting.

3.02 PROTECTION

A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, OSHA regulations.

B. Protect existing improvements including landscaping against damage. Repair or replace damaged items.

C. Protect existing utility services and distribution systems from damage or displacement.

D. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of two feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.

E. Shore, crib, or lag excavations and earthen banks as necessary to prevent cave in, erosion or gullying of sides.

F. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed earth and fill as required. Slope adjacent grades away from excavations to minimize entry of water.

3.03 SHORING

A. Provide shoring as necessary to properly and safely support earth sides of excavations, and existing curbs, sidewalks, gutter, drives and stairs, against movement and collapse.

B. Design and Calculations: Provide in accordance with requirement of governing Cal-OSHA requirements.

C. Remove shoring upon completion of the Work of this Section or when no longer needed unless required otherwise by authorities having jurisdiction.

3.04 EXCAVATION

A. Unclassified Excavations: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork", except as modified herein.

B. Form sides of footings, pads, grade beams, and slab foundations, unless otherwise indicated. Provide excavations of sufficient size to permit installation and removal of forms and other required Work.

C. Machine-drill excavation for round footings to size and depth indicated. Provide a collar or casing, or other adequate protection, to exclude dirt and debris. Protect excavations with plank covers until concrete is placed.

D. Provide excavation bottoms level and free from loose material. Excavate to indicated or required elevations of undisturbed earth.

E. Barricade trenches, ditches, pits, sumps, and similar Work outside the barricaded working area with chain link fence as specified in Section 01 5000 - Construction Facilities and Temporary Controls, and in accord with Cal-OSHA standards and requirements.

F. Trenches over five feet in depth shall comply with the Construction Safety Orders of the California Division of Industrial Safety.

G. Where indicated or required to excavate in lawn areas, protect adjoining lawn areas outside of the Work area. Replace or install removed sod upon completion of backfill by installing sod level with adjacent lawns. If installation of removed sod fails, furnish sod and install to match existing lawns.

H. For Structures:

1. Calculate excavation quantities based on elevations or depths indicated on Drawings.

2. Provide 2,000 psi concrete for backfill of over-excavated areas to indicated or required elevations.

3. Special preparation of bottom of excavated planes areas: Excavate areas shown on Drawings as bottom of excavated planes (B.E.P.), by excavating and filling to indicated grades and elevations.

I. For Utilities:

1. Excavate trenches to required depth for utility lines, such as pipes, conduits, and tanks, with minimum allowance of 6 inches at the bottom and 6 inches at the sides for bedding or concrete encasement as indicated on Drawings. Grade bottom of trenches to a uniform smooth surface. Remove loose soil from the excavation before placing sand bedding or concrete encasement.

2. Do not install piping lengthwise under concrete walks without review by the ARCHITECT.

3. Do not excavate trenches parallel to footings closer than 18 inches from the face of the footing or below a plane having a downward slope of two horizontal to one vertical, from a line 9 inches above bottom of footings.

   a. Unless otherwise indicated on Drawings, depth of excavations outside buildings shall provide for a minimum coverage above top of piping, tank or conduit measured from the lowest adjoining finished grade, as follows:

Steel Pipe	24 inches below finish grade
Copper Water Tube	18 inches below finish grade
Cast-Iron, Pressure Pipe	36 inches below finished grade
Plastic Pipe (other than waste)	30 inches below finished grade
Tanks or other structure	36 inches below finished grade
	Soil, sewer and storm drain minimum 18 inches below finished grade, and as required for proper pitch and traffic load. Install polypropylene sewer pipe with at least 24 inches of coverage.
Irrigation Pipe:	Non-pressure pipe - 12 inches, pressure pipe - 24 inches.

   b. Trench width shall provide space for fitting and joining. Excavate for piping bells and fittings, bell and spigot pipe and other fittings.

4. Where portions of existing structures, walks, paving, or other improvements are removed or cut for piping or conduit installation, replace the material with equal quality, finished to match adjoining existing improvements. Repair pavement as specified in Section 32 0117 - Pavement Repair.

5. Provide a minimum clear dimension of 2 inches from sides of wall excavation to outer surfaces of buried pipes or conduits placed in the same trench or outside surfaces of containers and tanks.

3.05 IMPORT/EXPORT OF MATERIALS

A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300 - Earthwork, except as modified herein. Install and compact fill in layers not to exceed 6 inches in thickness.

B. Provide fill materials as specified in Part 2- Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.

C. In addition to the requirements of this Section, import and/or exported materials shall comply with the requirements of Section 01 4524, Environmental Import/Export Materials Testing.

D. Imported fill materials shall be sampled by the Geotechnical Engineer, for compliance with the requirements of Part 2 of this Section.

E. The Geotechnical Engineer, will submit the samples to an independent DSA approved testing laboratory for testing.

F. Initial sampling and testing shall be performed before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and entity responsible for the source site. The Geotechnical Engineer, will obtain both the initial and additional samples from the identified site and submit samples for required testing.

G. The Geotechnical Engineer will perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.

H. The independent approved testing laboratory will perform the required tests and report results of tests noting if the tested material passed or failed such tests and will furnish copies to the Project Inspector, ARCHITECT, OAR, DSA, CONTRACTOR, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, California Building Code, and the DSA. Upon completion of the Work of this Section, the independent testing laboratory and Geotechnical Engineer will submit a verified report to the DSA as required by the CBC.

I. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.

J. Upon completion of import operations, provide the OAR a certification statement attesting that imported material has been obtained from the identified source site.

3.06 INSTALLATION OF MATERIALS

A. Pavement: Fill or backfill materials shall be installed in horizontal layers of 6 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the Geotechnical Engineer, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but not more than 1 in 20. Provide adequate drainage at all times during installation of the Work of this Section.

B. Structures:

1. After concrete has been placed, forms removed, and concrete Work inspected, backfill excavations with earth to indicated or required grades. Backfill simultaneously on each side of walls or grade beams. Remove rubbish, debris and other waste materials from excavations before placing backfill.

2. Before placing backfill, adequately cure concrete and provide bracing, if required to stabilize structure. Protect waterproofing or damp-proofing against damage during backfilling operations, with required protection board. Remove bracing as backfill operation progresses.

3. Do not furnish or install expansive soils for retaining wall backfill.

4. Rigidly control the amount of water to be installed to provide optimum moisture content for type of fill material furnished. Do not over-saturate or compact by flooding or jetting.

5. Install wall backfill before installing railings and fences on walls.

6. Install weep hole drainage at the backside of walls so the backing completely covers the weep holes, is horizontally centered and extends at least 12 inches above the bottom of the weep opening. Provide an 8-inch square section of 1/4 inch galvanized or aluminum screen, with a minimum wire diameter of 0.03 inch, and install at the backside of each weep hole before installing the backfill material.

7. Where a reviewed drainage matting system is provided instead of permeable backfill for retaining structures, install in accordance with the manufacturer recommendations.

C. Utilities:

1. Do not install backfill until the Work of this Section has been inspected and tested. Do not furnish or install materials excavated from the Project site containing materials not permitted for backfill.

2. Backfill electrical or other excavated utility trenches located outside of barricaded installation areas within 24 hours after inspection by the IOR.

3. Install backfill in layers not exceeding 4 inches in thickness, except cement-sand slurry.

4. If materials excavated from the Project site are not permitted for trench backfill in paved areas, backfill trenches with a cement-sand slurry mix. Install backfill to an elevation of the existing undisturbed grades plus one inch.

3.07 COMPACTING

A. Each layer of fill material shall be compacted by tamping, sheepsfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.

B. Install and compact sand bedding to provide a uniform bearing under the full length of piping and conduits.

C. Unless otherwise indicated, compact each layer of fill material to a relative compaction of at least ninety percent.

D. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each layer of compacted fill before installing the next succeeding layer.

3.08 INSPECTION AND TESTING

A. The Geotechnical Engineer will inspect and test excavations, sample material quality for testing as set required in Part 2 and observe installation and compaction of fill materials.

B. The Geotechnical Engineer will sample imported fill materials from their designated source and submit samples to the independent approved testing laboratory before delivery to the Project site.

C. Installation of backfill shall be observed by the Geotechnical Engineer.

D. The Geotechnical Engineer will inspect and test excavation Work before the installation of fill and other materials.

E. Compaction: Test compaction in accordance with ASTM D1557, Method C.

F. The Project Inspector will inspect foundation excavations when completed and ready for forms, after forms are in place, and before first placement of concrete.

3.09 PROTECTION

A. Protect the Work of this Section until Substantial Completion.

3.10 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 31 23 16 - EXCAVATION AND FILL FOR PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavating, backfill, and compacting for paved areas.
2. Installation of fill materials.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 4524 - Environmental Import/Export Materials Testing.
3. Section 31 1000 - Site Clearing.
4. Section 31 2200 - Grading.
5. Section 31 2323 - Excavation and Fill for Utilities.
6. Section 32 2326 - Base Course.
7. Section 32 0117 - Pavement Repair.
8. Section 32 1216 - Asphalt Paving.
9. Section 32 1313 - Site Concrete Work.

1.02 PROJECT REQUIREMENTS

A. Import and Export of Earth Materials:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

1.03 QUALITY ASSURANCE

A. Comply with Standard Specifications for Public Works Construction, current edition, except as modified herein.

B. Sampling, testing, and certification of imported and/or exported soils shall be performed in accordance with Section 01 4524 - Environmental Import/Export Materials Testing.

1.04 TESTING

A. OWNER will retain a Geotechnical Engineer as an OWNER Consultant who will provide observations, tests, inspections and approvals identified in the Contract Documents as being responsibility of OWNER.

B. Imported Soils: The Geotechnical Engineer will obtain initial product Sample for testing in accordance Article 3.05 of this Section.

1.05 PROJECT CONDITIONS

A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

PART 2 - PRODUCTS

2.01 BASE MATERIALS

A. Concrete Slabs On Grade: Provide “Crushed Aggregate Base “as specified in the Standard Specifications for Public Works Construction, Section 200: “Rock Materials,” with ¾ inch maximum size aggregates. Provide 3-inch thick base, unless noted otherwise.

B. Bituminous Surfacing: As indicated on Drawings and specified in Section 31 2326 - Base Course.

2.02 FILL AND BACKFILL MATERIALS

A. Fill and backfill materials shall be previously excavated materials or imported fill material, free of clods and stones larger than 3-inch, foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.

B. Fill material exhibiting a wide variation in consistency and moisture content shall be blended or aerated to stabilize and upgrade the material.

C. Imported Fill Material:

1. Provide suitable materials obtained from Project site excavations for earthwork and fill materials. If excavated materials are not of suitable quality or sufficient quantity, import additional materials as necessary.

2. Imported fill shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing 200 mesh sieve. Material shall have a coefficient of expansion of not

more than 2 percent from air dry to optimum moisture content and not more than 6 percent from air dry to saturation. Imported material shall be clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.

D. Brick rubble and broken concrete originating from the Project site shall be legally disposed of off the Project site. No such materials shall be imported from outside the Project site.

E. Permeable Backfill:

1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:

Sieve Size:	Percentage Passing:
3/4 inch (19mm)	100
3/8 inch (10mm)	80 to 100
No. 100	0 to 8
No. 200	0 to 3

2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.

3. Provided backing for weep holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.

4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system, Miradrain by Mirafi, Inc., or equal, may be provided if reviewed and approved by the ARCHITECT.

PART 3 - EXECUTION

3.01 GENERAL

A. Before initiating intrusive activities, contact Underground Service Alert of Southern California (USA or Dig Alert) to obtain a Dig Alert ticket for location information on buried public and USA member utilities and pipelines at least 48-hours prior to beginning work. A copy of the Dig Alert ticket shall be forwarded to the OWNER. For on-site utilities, retain a state-licensed third party underground utility locating service.

B. Clear the Project site as indicated in Section 31 1000 - Site Clearing.

3.02 PROTECTION

A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, Cal-OSHA regulations.

B. Protect adjacent existing improvements including landscaping against damage.

3.03 EXISTING UTILITY LINES

A. Protect existing utility lines from damage or displacement.

B. Remove conduits or pipes not in service, exposed during Work, unless a minimum cover of 2 feet is provided. Remove concrete, clay or other non-metallic pipe over 8 inches in diameter, unless otherwise indicated.

3.04 EXCAVATION

A. Unclassified Excavations: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.

3.05 FILL

A. Unclassified Fill and Compaction: Comply with the Standard Specifications for Public Works Construction, Section 300: "Earthwork," except as modified herein.

B. Provide fill materials as specified in Part 2 - Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.

C. In addition to the requirements of this Section, import and/or exported materials shall comply with the requirements of Section 01 4524 - Environmental Import/Export Materials Testing.

D. Imported fill materials will be sampled by the Geotechnical Engineer for compliance with the requirements of Part 2 of this Section.

E. The Geotechnical Engineer will submit samples to a DSA approved independent approved testing laboratory for testing.

F. Initial sampling will be performed by the Geotechnical Engineer before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The Geotechnical Engineer will obtain both the initial and additional samples from the identified site and will submit samples to the approved independent testing laboratory for testing.

G. The Geotechnical Engineer will perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic

yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.

H. The independent approved testing laboratory will perform the required tests and report results of tests noting if the tested material passed or failed such tests and will furnish copies to the Project Inspector, ARCHITECT, OAR, DSA, CONTRACTOR, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, CBC, and the DSA. Upon completion of the Work of this Section, the independent testing laboratory and Geotechnical Engineer shall submit a verified report to the DSA as required by CBC.

I. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.

J. Upon completion of import operations, provide the OAR a certification statement attesting that imported material has been obtained from the identified source site.

3.06 INSTALLATION OF MATERIALS

A. Fill or backfill materials shall be installed in horizontal layers of 6 inches, unless otherwise required. Each layer shall be evenly placed and moistened or aerated as necessary. Unless otherwise reviewed by the Geotechnical Engineer, each layer of fill material shall cover the length and width of the area to be filled before the next layer of material is installed. Top surface of each layer shall be installed to an approximate level with a crown or crossfall of at least 1 in 50, but no more than 1 in 20. Provide adequate drainage at all times during construction of the Work of this Section.

3.07 COMPACTING

A. Each layer of fill material shall be compacted by tamping, sheepsfoot rollers, or pneumatic-tired rollers to provide specified relative compaction. At inaccessible locations, provide specified compaction by manually held, operated and directed compaction equipment.

B. Unless otherwise indicated, compact each layer of earth fill to a relative compaction of at least 90 percent.

C. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each compacted layer before installing the next succeeding layer.

3.08 INSPECTION AND TESTING

A. The Geotechnical Engineer will inspect and test excavations, sample material quality as required in Part 2, and observe installation and compaction of fill materials.

B. The Geotechnical Engineer will sample imported fill materials from their designated source before delivery to the Project site.

C. Installation of backfill will be observed by the Geotechnical Engineer.

D. The Geotechnical Engineer will inspect and test excavation Work before the installation of fill and/or other materials.

E. Compaction: Test compaction in accordance with ASTM D1557, Method C.

3.09 PROTECTION

A. Protect the Work of this Section until Substantial Completion.

3.10 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 31 23 19 - EXCAVATION AND FILL FOR STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavating, backfilling, and compacting for buildings and structures.
2. Fill materials.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 4524 - Environmental Import/Export Materials Testing.
3. Section 31 1000 - Site Clearing.
4. Section 31 2200 - Grading.
5. Section 31 2616 - Excavation and Fill for Paving.
6. Section 31 2323 - Excavation and Fill for Utilities.

1.02 PROJECT REQUIREMENTS

A. Import and Export of Earth Materials:

1. Fees: Pay as required by authorities having jurisdiction over the area.
2. Bonds: Post as required by authorities having jurisdiction over the area.
3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

1.03 SUBMITTALS

A. Imported Soils: A Geotechnical Engineer, retained by the Owner as an Owner Consultant, will obtain initial product Sample for testing in accordance with the terms of Article 3.05 of this Section.

B. Shoring calculations as required in Article 3.03 of this Section.

1.04 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction, current edition, except as modified herein.

B. Sampling, testing, and certification of imported and/or exported soils shall be performed in accordance with Section 01 4524 - Environmental Import/Export Materials Testing.

1.05 TESTING

A. OWNER will retain a Geotechnical Engineer as an OWNER Consultant who will provide observations, tests, inspections and approvals identified in the Contract Documents as being responsibility of OWNER.

B. Imported Soils: The Geotechnical Engineer will obtain initial product Sample for testing in accordance Article 3.05 of this Section.

1.06 PROJECT CONDITIONS

A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

PART 2 - PRODUCTS

2.01 FILL AND BACKFILL MATERIALS

A. Fill and backfill materials shall be a granular material previously removed from excavation, or imported fill material, free of large clods and stones larger than 3 inches, foreign materials, vegetable growths, sod, expansive soils, rubbish and debris. Material shall conform to these specified requirements and related sections.

B. Fill material exhibiting a wide variation in consistency and or moisture content shall be blended and/or aerated to stabilize and upgrade the material.

C. Imported Fill Material:

1. Provide suitable materials obtained from Project site excavations for earthwork and fill materials. If excavated materials are not of suitable quality or sufficient quantity, import additional materials as necessary.

2. Imported fill shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing 200 mesh sieve. Material shall have a coefficient of expansion of not more than two percent from air dry to optimum moisture content and not more than six percent from air dry to saturation. Imported material shall be clean and free of rubbish, debris and toxic or hazardous contaminants. Adobe or clay soils are not permitted.

D. Brick rubble and broken concrete originating from the Project site shall be legally disposed of off the Project site No such materials shall be imported from outside the Project site.

E. Permeable Backfill:

1. Provide permeable backfill material behind retaining structures consisting of gravel, crushed gravel, crushed rock, natural sands, manufactured sand, or combinations of these materials conforming to the following gradations:

Sieve Size	Percentage Passing
3/4 inch	100
3/8 inch	80 to 100
No. 100	0 to 8
No. 200	0 to 3

2. Those portions of fill material passing a No. 4 sieve shall provide a sand equivalent of at least 60.

3. Provided backing for weep-holes shall consist of two cubic feet of aggregate in burlap sacks, securely tied. Aggregate shall conform to requirements for No. 3 concrete aggregate as specified in subsection 200-1.4 of the Standard Specifications for Public Works Construction.

4. Permeable Backfill Alternate Materials: Instead of the materials specified for retaining structures backfill, a drainage matting system, Miradrain by Mirafi, Inc., or equal, may be provided if reviewed and approved by the ARCHITECT.

PART 3 - EXECUTION

3.01 GENERAL

A. Before initiating intrusive activities, contact Underground Service Alert of Southern California (USA or Dig Alert) to obtain a Dig Alert ticket for location information on buried public and USA member utilities and pipelines at least 48-hours prior to beginning work. A copy of the Dig Alert ticket shall be forwarded to the OWNER. For on-site utilities, retain a state-licensed third party underground utility locating service.

B. Clear the Project site as indicated in Section 31 1000 - Site Clearing.

3.02 PROTECTION

A. Protect and guard excavations against danger to life, limb, and property as required by, but not limited to, Cal-OSHA regulations.

B. Protect adjacent existing improvements including landscaping against damage.

C. Shore, crib, or lag excavations and earthen banks as necessary to prevent caving-in, erosion or gullying of sides.

D. Divert or de-water excavations until concrete is placed, forms are removed, and backfilling is complete.

3.03 SHORING

A. Provide shoring as necessary to properly and safely support earth sides of excavations, curbs, sidewalks, gutter, drives and stairs, against movement and collapse.

B. Design and Calculations: Provide in accordance with requirement of Cal-OHSA. Remove shoring upon completion of Work, or when no longer needed.

3.04 EXCAVATION

A. Form sides of footings, pads, grade beams, and slab foundations, unless otherwise indicated. Provide excavations of sufficient size to permit installation and removal of forms and other Work as required.

B. Machine-drill excavation for round footings to size and depth indicated. Provide a collar or casing, or other adequate protection, to exclude dirt and debris. Protect excavations with plank covers until concrete is placed.

C. Provide excavation bottoms level and free from loose material. Excavate to indicated or required elevations of undisturbed earth.

D. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed soil and fill as required. Slope adjacent grades away from excavations to minimize entry of water.

E. Calculate excavation quantities based on elevations or depths indicated on Drawings.

F. Provide 2,000 psi concrete for backfill of over-excavated areas to indicated or required elevations.

G. Special preparation of bottom of excavated planes areas: Excavate areas designated on Drawings as bottom of excavated planes (B.E.P.), by excavating and filling to indicated grades and elevations.

3.05 IMPORT/EXPORT OF MATERIALS

A. Provide fill materials as specified in Part 2- Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.

B. In addition to the requirements of this Section, import and/or exported materials shall comply with the requirements of Section 01 4524 - Environmental Import/Export Materials Testing.

C. Imported fill materials will be sampled by the Geotechnical Engineer for compliance with the requirements of Part 2 of this Section.

D. The geotechnical engineer will submit all samples to a DSA approved independent testing laboratory for testing.

E. Initial sampling will be performed by the Geotechnical Engineer before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The Geotechnical Engineer will obtain both the initial sample and additional samples from the identified site and will submit samples to the approved independent testing laboratory for testing.

F. The Geotechnical Engineer will perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.

G. The independent approved testing laboratory will perform the required tests and report results of tests noting if the tested material passed or failed such tests and will furnish copies to the Project Inspector, ARCHITECT, OAR, DSA, CONTRACTOR, and others as required. Report shall state tests were conducted under the responsible charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, CBC and the DSA. Upon completion of the Work of this Section, the independent testing laboratory and Geotechnical Engineer will submit a verified report to the DSA as required by CBC.

H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.

I. Upon completion of import operations, provide the OAR a certification statement attesting that all imported material has been obtained from the identified source site.

3.06 BACKFILLING

A. After concrete has been placed, forms removed and concrete Work inspected, backfill excavations to indicated or required grades. Backfill simultaneously on each side of walls or grade beams. Remove rubbish, debris, and other waste materials from excavations before placing backfill.

B. Before installing backfill, adequately cure concrete and provide bracing to stabilize structures. Protect waterproofing or dampproofing against damage during backfilling

operations with required protection board. Remove bracing as backfill operation progresses.

C. Do not furnish or install expansive soils for below grade building walls.

D. Install each layer of material in a not to exceed thickness of 6 inches, unless otherwise required.

E. Rigidly control the amount of water to be installed to provide optimum moisture content for type of fill material furnished. Do not over-saturate or compact by flooding or jetting.

F. Install wall backfill before installing railings and fences on walls.

G. Impervious backfill materials shall be installed in layers along with and by the same methods specified for structure backfill. Impervious backfill materials shall be at the approximate grade and elevation and where exposed to erosion, shall be covered with at least a 12-inch layer of fill material as reviewed by the Geotechnical Engineer.

H. Install weep hole drainage at the backside of walls so the backing completely covers the weep holes, is horizontally centered and extends at least 12 inches above the bottom of the weep opening. Provide an 8-inch square section of 1/4 inch galvanized or aluminum screen, with a minimum wire diameter of 0.03 inch, and install at the backside of each weep hole before installing the backfill material.

I. Where a reviewed drainage matting system is provided instead of permeable backfill for retaining structures, install in accordance with the manufacturer recommendations.

3.07 COMPACTING

A. Compact each layer of fill material by tamping, sheepsfoot rollers or pneumatic-tired rollers, to such extent as to provide specified relative compaction. At inaccessible locations, compact to specified requirements with hand-held, operated and directed compaction equipment.

B. Unless otherwise indicated, compact each layer of fill material to a relative compaction of at least 90 percent.

C. Do not compact by flooding or jetting.

D. When fill materials, or a combination of fill materials, are encountered or provided which develop densely packed surfaces as a result of installation or compacting operations, scarify each layer of compacted fill before installing the next succeeding layer.

3.08 INSPECTION AND TESTING

A. The Geotechnical Engineer will inspect and test excavations, sample material quality as required in Part 2, and observe installation and compaction of fill materials.

B. The Geotechnical Engineer will sample imported fill materials from their designated source before delivery to the Project site.

C. Installation of backfill shall be observed by the Geotechnical Engineer.

D. The Geotechnical Engineer will inspect and test excavation Work before the installation of fill and/or other materials.

E. Compaction: Test compaction in accordance with ASTM D1557, Method C.

F. The Project Inspector will inspect foundation excavations when completed and ready for forms, after forms are in place and before first placement of concrete.

3.09 PROTECTION

A. Protect the Work of this Section until Substantial Completion.

3.10 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 31 23 23 - EXCAVATION AND FILL FOR UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavating, backfilling, and compacting utility trenches such as water, gas, irrigation, storm drain, sewer lines, concrete-encased conduits, and manholes, vaults, valve boxes, catch basins, underground tanks, thrust blocks, yard boxes, pull boxes and other utility appurtenances.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 01 4524 - Environmental Import/Export Materials Testing.
3. Section 31 1000 - Site Clearing.
4. Section 31 2200 - Grading.
5. Section 31 2316 - Excavation and Fill for Paving.
6. Section 31 2319 - Excavation and Fill for Structures.
7. Section 32 0117 - Pavement Repair.
8. Section 32 1313 - Site Concrete Work.
9. Section 32 8413 - Potable Water Irrigation.
10. Section 32 8426 - Reclaimed Water Irrigation.
11. Section 33 1100 - Site Water Distribution Utilities.
12. Section 33 3000 - Site Sanitary Sewer Utilities.
13. Section 33 4000 - Storm Drainage Utilities.
14. Division 22 - Plumbing.
15. Division 26 - Electrical.

1.02 PROJECT REQUIREMENTS

A. Import and Export of Earth Materials:

1. Fees: Pay as required by authorities having jurisdiction over the area.

2. Bonds: Post as required by authorities having jurisdiction over the area.

3. Haul Routes and Restrictions: Comply with requirements of authorities having jurisdiction over the area.

1.03 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement: Standard Specifications for Public Works construction, current edition except as modified herein.

B. Sampling, testing, and certification of imported and/or exported soils shall be performed in accordance with Section 01 4524 - Environmental Import/Export Materials Testing.

1.04 TESTING

A. OWNER will retain a Geotechnical Engineer as an OWNER Consultant who will provide observations, tests, inspections and approvals identified in the Contract Documents as being responsibility of OWNER.

B. Imported Soils: The Geotechnical Engineer will obtain initial product Sample for testing in accordance Article 3.02 of this Section.

1.05 PROJECT CONDITIONS

A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Bedding material from trench bottom to one foot above the pipe:

1. Sand, gravel, crushed aggregate or native free-draining granular material providing a sand equivalent of at least 30 or a coefficient of permeability greater than 1.4 inches per hour.

2. Sand complying with the Specifications for cement concrete aggregates.

B. Backfill Materials:

1. Excavated trench material to be installed for backfilling shall be clean, free of large clods, and stones larger than 2 ½-inch in any dimension.

2. Cement-sand slurry shall be provided with one sack of cement per cubic yard of the mixture.

3. Imported Fill Material: Imported fill material shall be a granular material with sufficient binder to form a firm and stable unyielding subgrade and shall not have more than 60 percent of fines passing a 200 mesh sieve. Material shall provide a coefficient of expansion of not more than two percent from air dry to optimum moisture content and not more than six percent from air dry to saturation. Imported materials shall be clean and free of rubbish, debris, and toxic or hazardous contaminants. Adobe or clay soils are not permitted.

PART 3 - EXECUTION

3.01 GENERAL

A. Before initiating intrusive activities, contact Underground Service Alert of Southern California (USA or Dig Alert) to obtain a Dig Alert ticket for location information on buried public and USA member utilities and pipelines at least 48-hours prior to beginning work. A copy of the Dig Alert ticket shall be forwarded to the OWNER. For on-site utilities, retain a state-licensed third party underground utility locating service.

B. Barricade trenches, ditches, pits, sumps, and similar Work outside the barricaded working area with chain link fence as specified in Section 01 5000, Construction Facilities and Temporary Controls, and in accordance with Cal-OSHA standards and requirements.

C. Saw-cut concrete or bituminous paving for trench installation.

D. Trenches over 5 feet in depth shall conform to the Cal-OSHA.

E. Where indicated and required to excavate in lawn areas, protect adjoining lawn areas outside of the Work area. Replace or install removed sod upon completion of backfill by installing sod level with adjacent lawns. If installation of removed sod fails, furnish sod and install to match existing lawns.

F. Backfill over excavations to the required elevations with earth, gravel, sand, or concrete and compact as required. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. Slope adjacent grades away from excavations to minimize entry of water.

G. Do not install piping lengthwise under concrete walks without review by the ARCHITECT.

H. Do not excavate trenches parallel to footings closer than 18 inches from the face of the footing or below a plane having a downward slope of two horizontal to one vertical, from a line 9 inches above bottom of footings.

1. Unless otherwise indicated on Drawings, depth of excavations outside the buildings shall allow for a minimum coverage above top of pipe, tank, or conduit measured from the lowest adjoining finished grade, as follows:

Steel Pipe	24 inches below finished grade
Copper Water Tube	18 inches below finished grade
Cast-Iron Pressure Pipe	36 inches below finished grade
Plastic Pipe (other than waste)	30 inches below finished grade
Tanks or other structures	36 inches below finished grade
Soil, Sewer & Storm Drain	minimum 18 inches below finished grade, and as required for proper pitch and traffic load. (Install polypropylene sewer pipe with at least 24 inches coverage)
Irrigation Pipe:	nonpressure pipe 12 inches, pressure pipe 24 inches

2. Trench width shall provide ample space for fitting and joining. Excavate for piping bells and fittings, bell and spigot pipe and other fittings.

I. Unless indicated otherwise, excavate trenches to the required depths for utilities, such as pipes, conduit and tanks, with minimum allowances of 6 inches at the bottom and 6 inches at the sides for bedding of unprotected piping or as required for concrete encasement of conduits as indicated on Drawings. Grade bottom of trenches to a uniform smooth surface. Remove loose soil from the excavation before installing sand bedding or concrete encasement.

J. Provide excavations free from standing water by pumping, draining, or providing protection against water intrusion. If soil becomes soft, soggy, or saturated, excavate to firm undisturbed soil and fill as required. Slope adjacent grades away from excavations to minimize entry of water.

K. Provide a minimum clear dimension of 2 inches from sides of wall excavation to outer surfaces of buried pipes or conduits installed in the same trench or outside surfaces of containers and tanks.

L. Do not install backfill until required inspections and testing is completed.

M. Backfill electrical or other excavated utility trenches located outside of barricaded installation areas within 24 hours after inspection by the Project Inspector.

N. Install backfill materials in layers not exceeding 4 inches in thickness and compact to 90 percent of the maximum density.

O. If materials excavated from the Project site are not permitted for trench backfill in paved areas, backfill trenches with a cement-sand slurry mix. Install backfill to an elevation of the existing undisturbed grade plus one inch.

P. Install and compact sand bedding to provide a uniform full length bearing under piping and conduits.

Q. Where portions of existing structures, walks, paving, or other improvements are removed or cut for piping or conduit installation, replace the material with equal quality, finished to match adjoining existing improvements. Repair pavement as specified in Section 32 0117, Pavement Repair.

3.02 IMPORT/EXPORT OF MATERIALS

A. Provide fill materials as specified in Part 2, Products. If excavated materials from the Project site are not of required quality or sufficient quantity, import additional materials as necessary.

B. In addition to the requirements of this Section, import and exported materials shall comply with the requirements of Section 01 4524, Environmental Import/Export Material Testing.

C. Imported fill materials will be sampled by the Geotechnical Engineer for compliance with the requirements of Part 2 of this Section.

D. The Geotechnical Engineer will perform the tests by utilizing an independent approved testing laboratory.

E. Initial sampling will be performed by the Geotechnical Engineer before importing material to the Project site. Identify the location of the source site in addition to the address, name of the person and/or entity responsible for the source site. The Geotechnical Engineer will obtain both the initial sample and additional samples from the identified site and shall submit all samples to the approved independent testing laboratory.

F. The Geotechnical Engineer will perform additional sampling during import operations. If the total quantity of import is determined to be greater than 1,000 cubic yards of material, one sample shall be obtained and submitted for testing for each 250 cubic yards of imported material. If the total quantity of import is determined to be less than 1,000 yards, one sample shall be obtained and submitted for testing for each 100 cubic yards of imported material.

G. The independent approved testing laboratory will perform the required tests and report results of all tests noting if the tested material passed or failed such tests and will furnish copies to the Project Inspector, ARCHITECT, OAR, DSA, CONTRACTOR, and others as required. Report shall state tests were conducted under the responsible

charge of a licensed State of California professional engineer and the material was tested in accordance with applicable provisions of the Contract Documents, CBC and the DSA. Upon completion of the Work of this Section, the independent testing laboratory and Geotechnical Engineer will submit a verified report to the DSA as required by CBC.

H. Bills of lading or equivalent documentation will be submitted to the Project Inspector on a daily basis.

I. Upon completion of import operations, provide the OAR a certification statement attesting that imported material has been obtained from the identified source site.

3.03 INSPECTION AND TESTING

A. The Geotechnical Engineer will inspect and test excavations, sample material quality as required in Part 2, observe installation and compaction of fill materials.

B. Compaction test shall be performed in accordance with ASTM D1557, method "C."

3.04 PROTECTION

A. Protect the Work of this Section until Substantial Completion.

3.05 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 31 23 26 - BASE COURSE

PART 1 - GENERAL

A. Related Sections

1. 01 45 24: Environmental Import Materials Testing
2. 01 45 25: Environmental Export Materials Testing
3. 31 23 00: Excavation and Backfill
4. 32 12 16: Asphalt Paving
5. 32 12 36: Seal Coats

B. Reference Standards

1. Conform to Section 200,2.2 of the Standard Specifications for Public Works Construction.
2. Conform to site specific geotechnical report for specified thickness.

PART 2 – PRODUCTS

A. Base Material

1. Use crushed aggregate base (CAB). Crushed miscellaneous base is not acceptable.
2. Crushed Aggregate Base Material shall conform to with the requirements of Standard Specifications for Public Works Construction, Section 200 – Rock Materials.
3. All import material must meet Department of Toxic Substance Control (DTSC) requirements. The District has experience with a few of the larger facilities for the import of construction materials that have been tested and accepted. For a current list of those facilities contact the District.

PART 3 – EXECUTION

A. Install aggregate base course material in layers not exceeding 4-inches.

B. Compact per the requirements of the soils report and drawings, or 95 percent if not noted.

END OF SECTION

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Paving for playground, parking areas, areas between buildings, synthetic track surfacing adjacent to planting and turf areas as indicated.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 31 2200 - Grading.
3. Section 32 0117 - Pavement Repair.
4. Section 31 2326 - Base Course.
5. Section 32 1236 - Seal for Bituminous Surfacing.
6. Section 32 1313 - Site Concrete Work.

1.02 SUBMITTALS

A. Shop Drawings: Submit site plan indicating extent of paving and accessories.

B. Product Data: Manufacturer’s technical data for materials and products.

1.03 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction.

1.04 PROJECT CONDITIONS

A. Information on Drawings or in soils report does not constitute a guarantee of accuracy or uniformity of soil conditions over the Project site.

B A copy of the soils report is available for examination in the office of the Architect during regular office hours of the Architect.

PART 2 - PRODUCTS

2.01 BITUMINOUS MATERIALS

A. Provide materials of the class, grade, or type indicated on the Drawings, conforming to relevant provisions of Section 203 - Bituminous Materials of the Standard Specifications for Public Works Construction.

2.02 HEADERS

A. Concrete: Per specification Section 32 1313 - Site Concrete Work.

B. Wood:

1. Redwood, Construction Heart Grade, size 2 by 6, unless otherwise indicated.

2. Stakes: 2 by 4 redwood or 2 by 3 Douglas fir, Construction Grade.

3. Nails: Common, galvanized, 12d minimum.

PART 3 - EXECUTION

3.01 HEADERS

A. Install headers along edge of bituminous surfacing abutting turf, earth, or planting area, unless indicated otherwise.

B. Install headers so the bottom surface has continuous bearing on solid grade. Where excavation for headers is undercut, thoroughly tamp soil under the header. Compact backfill on both sides of header to the density of adjacent undisturbed earth.

C. Where wood headers are indicated on drawing, fasten headers in place with redwood or Douglas fir stakes of length necessary to extend into solid grade a minimum of 12 inches. Stakes shall be of sound material, neatly pointed, driven vertically, and securely nailed to headers. Space stakes, not to exceed 4 feet on center with top of stakes set one inch below top of header. Provide a minimum of two 12d galvanized common nails through each stake.

D. Remove existing headers where new surfacing is installed adjacent to existing surfacing.

E. Install temporary headers at transverse joints of paving where continuous paving operations are not maintained.

F. Provide additional stakes and anchorage as required to fasten headers in place.

3.02 CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

A. Thickness of Surfacing: Unless otherwise indicated on Drawings or specified, install bituminous surfacing to a compacted thickness of 2 inches.

B. Provide surfacing material over base course as specified in Section 31 2326 - Base Course.

C. Surfaces of walls, concrete, masonry, or existing bituminous surfacing indicated to be in direct contact with installed bituminous surfacing shall be cleaned, dried and uniformly coated with an asphaltic emulsion film.

D. Thicken edges of bituminous surfacing that do not abut walls, concrete, or masonry, and edges joining existing bituminous surfaces. Remove headers at existing bituminous surfacing where new bituminous surfacing is to be installed. Thicken edges an additional 2 inches and taper to the indicated or specified thickness 6 inches back from such edges.

E. Provide adequate protection for concrete, planting areas, and other finish Work adjacent to areas indicated to receive bituminous surfacing.

F. Placing:

1. Do not install bituminous surfacing when atmospheric temperature is below 40 degrees F; or when fog or other unsuitable weather conditions are present. Temperature of mixture at time of installation shall not be lower than 260 degrees F in warm weather or higher than 320 degrees F in cold weather.

2. Where 2-inch or 3-inch thick surfacing is indicated or specified, install surfacing in one course. Where surfacing is indicated or specified 4 inches or more in thickness, except for thickened edges, install bituminous surfacing in courses of approximately equal thickness, each course not exceeding 2 ½ inches in thickness.

G. Stakes or Screeds: Provide grade or screed stakes spaced not more than 15 feet apart in flow lines with grades of less than one percent. Continuous screeds may be provided instead of stakes.

H. Spreading: Install bituminous surfacing in a manner to cause least possible handling of mixture. In open areas and wherever practicable, install by mechanical means with a self-propelled mechanical spreader. In confined or restricted areas, install mixture with hot shovels and rakes, and smooth with lutes.

I. Joints: Provide vertical joints between successive runs. Install joints true to line, grade, and cross section. Lapped joints are not permitted.

J. Rolling:

1. Finish roll with a self-propelled tandem roller weighing at least 8 tons. Break down roll with a self-propelled roller weighing between 1 ½ tons and 8 tons.

2. Roll in a manner that preserves flow lines and the established finished grades. Break down roll in areas adjacent to flow lines parallel to flow lines. Break down roll after bituminous surfacing is installed without shoving or cracking of mixture under roller. Continue finish rolling until surfacing is unyielding, true to grade, and meets requirements for specified smoothness. Areas inaccessible to finish roller may be finish rolled with breakdown roller or tamped with hot tamping irons and smoothed with hot smoothing irons or hand roller.

3. Where bituminous surfacing abuts concrete, masonry, walks or paving, tamp joint smooth, if necessary, as described above to obtain a uniformly even joint, true to line and grade. Tamp and smooth to properly compact.

4. Compacted bituminous surfacing shall be provided with a bulk specific gravity of at least 2.31 when tested in accordance with ASTM D1188.

3.03 TOLERANCE

A. Smoothness: Surface of bituminous surfacing after rolling, shall be even, smooth and uniform in texture with no voids or rock pockets, free of roller marks or other irregularities, and not varying by more than 0.03 foot, except at local depressions or raised areas as indicated, when a 10-foot straightedge is placed on surface.

B. Grade: Finished grade shall not vary more than 0.02 foot above or below required grade. Variations within prescribed tolerance shall be compensating so that average grade and cross-section are provided.

C. Premium paving tolerances and requirements for synthetic track:

1. General: Test in-place asphalt concrete courses for compliance with requirements or thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Owner's representative.

2. Thickness: Tolerances for thickness shall be ¼ inch, plus or minus.

3. Planarity: The asphalt substrate shall not vary from the planned cross slope by more than plus or minus 0.1 percent. The finished asphalt shall not vary, plus or minus, under a 10 feet straight edge greater than 1/8 inch. Flood test the surface with the use of a water truck. If, after 30 minutes on a 70 degree F day, "bird baths" are evident at a depth more than 1/8 inch repair using the best method of correction.

4. Corrective Measures: Determine if the planarity, cross slopes, and general specifications have been met. If all of the conditions have been met notify the Owner in writing of the acceptance of the asphalt paving.

5. No slurry or fog seals are to be applied to areas of asphalt paving that are to receive synthetic track surfacing.

3.04 TESTING

A. After first coat of surface seal has been installed and after a 24 hour period, the flood test shall be completed of the bituminous surfacing in presence of the Project Inspector. Repair areas of standing water or puddles and flood test locally; install surface seal and retest as necessary.

3.05 SURFACE SEALING

A. After bituminous surfacing has passed flood test, clear and allow to dry and provide one more coat of surface seal as specified in Section 32 1236 - Seal for Bituminous Surfacing.

B. Where indicated, provide multiple coats of surface seal to existing bituminous surfacing.

C. Where new bituminous surfacing joins existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.

3.06 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.07 CLEANUP

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 32 12 36 – SEAL BITUMINOUS SURFACING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Surface sealer over bituminous surfacing.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 32 0117 - Pavement Repair.
3. Section 32 1216 - Asphalt Paving.
4. Section 32 1723 - Pavement Marking.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product information and application procedures for bituminous surfacing.

1.03 QUALITY ASSURANCE

A. Comply with the Standard Specifications For Public Works Construction, current edition.

B. Agitate bulk materials during transport.

1.04 MAINTENANCE

A. Extra Materials: Provide 10 gallons in unopened containers.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide one of the following surface seals:

	Product Name	Manufacturer
1.	Guard-Top	CALMAT / Industrial Asphalt
2.	Over Kote	Diversified Asphalt Product
3.	Park Top	Western Colloid Products
4.	Sure Seal	Asphalt Coating Engineering
5.	Super Drive Top.	SAF– T Seal. Inc.

6. Equal.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Thoroughly wash surfaces with water to remove dirt, debris, excessive oil and grease, or other foreign matter.

3.02 APPLICATION

A. Install seal coat in strict accordance with manufacturer's written directions and recommendations.

B. Install two coats of surface seal to new bituminous surfacing. First coat shall be installed before flood testing. Clean surface and allow to dry before installing second coat. Second coat shall be installed after bituminous surfacing has passed flood test.

C. Where new bituminous surfacing is installed adjacent to existing bituminous surfacing, overlap surface seal a minimum of 12 inches onto existing bituminous surfacing.

D. Where existing bituminous surfacing is indicated to be patched and sealed, install two coats of surface seal after patching. Refer to Section 32 1216 - Asphalt Paving.

3.03 PROTECTION OF SURFACES

A. Protect sealed and unsealed surfaces from damage and traffic during performance of the Work of this section and until surface seal has thoroughly set and cured. Do not permit traffic of any kind for at least 24 hours after completion of installation.

B. Protect the Work of this section until Substantial Completion.

3.04 TESTING

A. Owner reserves the right to obtain samples, perform tests to ensure compliance with the Specifications, and to review weight slips and invoices of materials delivered to the Project site.

3.05 CLEAN UP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 32 13 13 – SITE CONCRETE WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: On-site concrete work:

1. Portland cement concrete pavement, driveways, curbs, gutters and mowing strips.
2. Ramps and stairs on grade.
3. Footings for fence posts, bollards, flagpoles, shade structures, light standards and athletic and playground equipment.
4. Pipe encasements, thrust blocks, and equipment pads.
5. Retaining walls, planter walls and concrete benches.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Section 03 3000 – Cast-in-Place Concrete.
3. Section 07 9200 – Joint Sealants.
4. Division 23 - HVAC.
5. Division 26 - Electrical.
6. Section 31 2200 – Grading.
7. Section 31 2316 - Excavation and Fill for Pavement.
8. Section 31 2326 - Base Course.
9. Section 32 1216 - Asphalt Paving.
10. Section 32 1723 – Pavement Markings.
11. Section 32 3113 - Chain Link Fences and Gates.

1.02 REFERENCES

A. Structural work, such as retaining walls, planter walls, cast-in-place benches, equipment pads, and footings for playground equipment, fences, walls, shade structures and flagpoles shall conform to the following Sections:

1. Section 03 3000 Cast-in-Place Concrete.

B. Flatwork, such as walkways, driveways, ramps and steps on grade, swales, curbs, mow strips and utility related concrete, conform to:

1. Standard Specifications for Public Works Construction, The “Greenbook”, except reclaimed aggregates and processed miscellaneous base are not allowed.

C. Imported or exported earthwork shall conform to Section 01 4524 Environmental Import / Export Materials Testing.

D. National Ready Mixed Concrete Association (NRMCA):

1. Checklist for the Concrete Pre-Construction Conference.

1.03 QUALITY ASSURANCE

A. Source Limitations for Exposed Concrete: Obtain each color, size, type, and variety of concrete material and concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties. Secure material required for the duration of the project as needed to ensure consistent quality in appearance.

B. Pre-Installation Conference:

1. CONTRACTOR shall coordinate and conduct pre-installation conference in conformance to Section 01 3119 Project Meetings.

2. CONTRACTOR shall use the NRMCA “Checklist for the Concrete Pre-Construction Conference” as the meeting agenda.

C. Mockup:

1. Build 8 feet by 8 feet mockups of full-thickness sections of concrete paving using processes and techniques intended for use on permanent work, including curing procedures.

2. Build mockups to demonstrate typical joints; surface finishes and standard of workmanship.

3. Obtain ARCHITECT’s approval of mockup before proceeding with work of this Section.

4. Mockup shall remain through completion of the work for use as a quality standard for finished work.

5. Remove mockup when directed by the OAR.

D. Field applied primers, paintings, sealers, sealants, caulking, leveling and patching compounds, crack/joint repair compounds adhesives and similar products shall be approved by the OWNER's Office of Environmental Health and Safety (OEHS).

1.04 SUBMITTALS

A. Flatwork: Submit mix design in conformance to the Greenbook.

B. Shop Drawings: Submit drawings indicating the locations of concrete joints, including construction joints, expansion joints, isolation joints, and contraction joints.

C. Submit concrete Sample of each specified color.

D. Submit full range of manufacturer's standard and custom range colors and products for ARCHITECT's review and selection.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store cement and aggregate materials so to prevent their deterioration or intrusion by foreign matter. Deteriorated or contaminated materials shall not be furnished.

B. Packaged materials shall bear the manufacturers and brand name label and shall be stored in their original unbroken package in a weather tight place until ready for use in the work.

C. Avoid exposure of reinforcing steel bars, wire, and wire fabric to dirt, moisture or conditions harmful to reinforcing.

D. Reinforcing steel bars, wire, and wire fabric shall be stored on the Project site to permit easy access for examination and identification of each shipment. Material of each shipment shall be separated by size and shape.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Structural Work: Conform to the applicable requirements of the following Sections, except as otherwise specified:

1. Section 03 1000 Concrete Forming.

2. Section 03 2000 Concrete Reinforcing.

3. Section 03 3000 Cast-in-Place Concrete.

4. Section 07 9200 Joint Sealants.

B. Flatwork: Conform to the applicable requirements of the Greenbook, Section 201, except as follows:

1. Water/cement ratio for concrete flatwork shall be 0.50 maximum.

2. Base course shall conform to Section 32 3226 Base Course.

3. Reclaimed concrete material shall not be used.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that gradients and elevations of base are correct. Maintain subgrade clean and in a smooth, compacted condition until the concrete is placed.

B. Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. Earth surface shall be kept moist by frequent sprinkling up to the time of placing concrete.

3.02 CONSTRUCTION OF FORMS

A. Flatwork Forming: Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 4 stakes per form placed at intervals not to exceed two feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms.

B. Wall Formwork: Forms shall be constructed to conform to final concrete shape, lines and dimensions of members required by Drawings and Specifications. Forms shall be sufficiently tight to prevent leakage of concrete and properly braced or tied together to maintain position and shape.

3.03 STEEL REINFORCEMENT INSTALLATION

A. Fabricate bars of the indicated sizes and bend and form to required shapes and lengths by methods not injurious to materials. Do not heat reinforcement for bending. Bend bars No. 6 size and larger in the shop only. Bars with unscheduled kinks or bends are not permitted.

B. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

C. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces, and lace splices with wire.

D. Clean reinforcement of loose rust and mill scale, earth, or bond-reducing materials.

3.04 PREPARATION FOR CONCRETE PLACEMENT

A. Surfaces to receive concrete shall be free of debris, standing water, and any other deleterious substances before start of concrete placing.

B. Do not place concrete until forms, reinforcement, pipe, conduits, outlet boxes, anchors, sleeves, bolts, and other embedded materials are securely fastened in place. Maintain a minimum of two inches clearance between said items and any part of the concrete reinforcement.

C. Adjust pull boxes, meter boxes, valve covers and manholes to proposed finish grade prior to placement of concrete. Anchor bolts shall be accurately set and maintained in position by templates while being embedded in concrete.

D. Clean thoroughly the surfaces of metalwork to be in contact with concrete, remove dirt, grease, loose scale and rust, grout, mortar, and other foreign substances before the concrete is placed.

E. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

3.05 CONCRETE PLACEMENT

A. Place, compact, screed, float and trowel concrete as indicated in Section 03 3000 Cast-in-Place Concrete.

B. Finish: After straight edging, when most of the water sheen has disappeared and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

1. Provide medium broom finish on surfaces up to six percent slope by striating surface 1/32 to 3/64 inch deep with a soft bristle broom across concrete surface to provide a uniform fine line texture.

2. Provide heavy broom finish on surfaces over six percent by striating surface 1/16 inch to 1/8 inch deep with a stiff-bristled broom.

3.06 JOINTS

A. Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated. Align curb, gutter, and sidewalk joints.

B. Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour.

1. Continue steel reinforcement across construction joints unless otherwise indicated on the Drawings.

2. Provide tie bars at sides of paving strips where indicated on the Drawings

3. Butt Joints: Use bonding agent or epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated on the Drawings.

D. Expansion Joints:

1. Provide premolded joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together. Extend expansion joint fillers full-width and depth of joint, and 1/4" below finished surface where joint filler is indicated. If no joint sealer is indicated place top of premolded joint filler flush with top of concrete or curb.

2. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints to a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Remove grooving-tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

F. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Remove edging-tool marks on concrete surfaces.

G. Where concrete is to be cast against old concrete, (greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by sand-blasting, exposing the aggregate. The hardened surface shall be cleaned of latent foreign material and washed clean, prior to the application of an epoxy bonding agent.

3.07 STAIRS AND RAMPS

A. Install support post sleeves into the perimeter concrete curbing during the installation process of the curbing. Sleeves shall be three-inch diameter, schedule 40 PVC with a cap solvent welded to the bottom of the sleeve. Drill a half-inch weep hole on the bottom of the cap. Sleeve and cap shall be Nibco products or approved equal. Sleeves shall be embedded into concrete a minimum of nine inches and spaced at a maximum of four feet, or as indicated on the Drawings. Fill sleeve with non-shrink grout Quickcrete #1585-01 when setting posts. Provide control joints into the concrete on both sides for each post.

3.08 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

A. Formed Curb and Gutter: Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Finish curve shaped gutters with a standard curb mule or concrete slipformed curb paving equipment.

B. Concrete Finishing: Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter to grade with a wood float.

C. Surface and Thickness Tolerances: Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.09 CLEAN UP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project Site.

3.10 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 32 13 16 – LANDSCAPE SITE CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Furnishing of services, labor, materials, transportation, tools and equipment necessary to perform the work indicated on the Drawings and specified herein as required to properly complete the work in this contract.

B. Related Documents: The Condition of the Contract and Division 1 apply to this section as fully as if repeated herein.

C. Related Work Specified Elsewhere:
1. 03 3310 Landscape Site Concrete Walls
2. 12 9300 Site Furnishings
3. 31 1000 Site Clearing
4. 31 2000 Earth Moving
5. 32 1413 Unit Paving
6. 32 3116 Fence and Gate
7. 32 8400 Landscape Irrigation
8. 32 9316 Exterior Plants
9. 33 4100 Storm Utility Drainage Piping

1.02 REFERENCES

A. Conform to the following codes and standards:
1. American Concrete Institute (ACI)
2. American Society for Testing and Materials (ASTM): The specifications and standards hereinafter referred.
3. Standard Specifications for Public Works Construction Current Edition.

1.03 SUBMITTALS

A. Comply with Section 01 33 00 Submittal Procedures.

B. Product Data: Furnish manufacturer’s product specifications and installation instructions for the following:
1. Color admixture
2. Reinforcement
3. Sealer and Sealants
4. Finish Retardants
5. Expansion joint filler material
6. Plastic Dowel Sleeves

C. Design Data: Furnish certified reports of proposed mix design for each type of concrete installation.

D. Submit delivery slips.

E. Submittals for above items shall be made in one package. If submittals are judged incomplete or non-responsive to the directions of the University's Representative after three (3) submissions the Contractor shall be back charged for the University's Representatives costs to process additional Submittals. Additional Submittal Procedures are specified in Section 01 33 00.

1.04 FIELD MOCK-UPS

A. Mock-up: Prepare at the job site, a sample panel not less than 4 feet by 4 feet of each color and finish indicated. If multiple colors and finishes are specified, all samples shall be prepared for review at the same time. Include joints and joint materials, caulking, and scoring treatments specified on the plans.

B. The Mock-ups shall be reviewed and approved by the University's Representative before proceeding with the work. Mock-ups that do not demonstrate all specified joints and joint materials, caulking, and scoring treatments will be rejected. Remove and reconstruct the mock- ups until approved. The Contractor shall be back charged for the costs of the University's Representative to review more than two (2) mock-up attempts. Approved mock-ups shall serve as standard of acceptance for paving work and remain available for the duration of the project.

C. Demolish and remove mock-ups at the completion of the project.

1.05 QUALITY ASSURANCE

A. Formwork: Comply with Recommended Practice for Concrete Formwork, ACI 347.

B. Qualifications: Refer to Section 01 43 00 Quality Assurance Requirements.

1.06 DELIVERY AND HANDLING

A. Conform to Section 01 60 00 Product Requirements.

B. Deliver, store, and handle reinforcement to prevent damage.

1.07 REGULATORY REQUIREMENTS

A. Testing: Slump tests shall be taken to certify compliance with mix design. Slump shall be in accordance with ASTM C 143.

B. Mix design shall be in accordance with ACI 211-6.

C. Conform to applicable laws, codes, and regulations required by authorities having jurisdiction over the work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Coarse Aggregate: Aggregate composed of gravel, crushed rock, or a blended mixture conforming to Standard Specifications Section 200-1.4. Aggregates shall be washed clean, uniformly screen graded, and contain not more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth loam, mica, or similar materials.

B. Fine Aggregate: Sand shall consist of a natural or manufactured granular material, or combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended. Sand shall be washed and conform to Standard Specifications Section 200-1.5.3.

C. Portland Cement: ASTM C 150, Type II. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBC Sections 11B-302 and 11B-403 and TITLE 24, Part 2, Section 3305(e).

D. Water: Clean and free from deleterious amounts of acids, alkali, oil, or organic materials.

E. Base Material: Crushed aggregate consisting entirely of crushed rock and rock dust, uniformly graded and meeting the requirements of Standard Specifications Section 200-2.2. At the time of spreading, the material shall have a moisture content sufficient to obtain the required compaction.

2.02 MIX DESIGN, COLOR, AND FINISH

A. Provide mix design in accordance with ACI 318. Mix designs shall be the responsibility of the Contractor.
   1. Contractor shall employ a Testing Laboratory approved by the Architect under the active direction of a Civil Engineer, who shall determine mix designs to fulfill the specified requirements for strength, aggregate size and workability of concrete, and such designs shall be used in proportioning all structural concrete.
      a. Mix designs shall be submitted to the Architect for review at least 10 days prior to scheduled concrete pour.
      b. Review by the Architect shall not be considered unqualified approval and shall not relieve the Contractor of his responsibility to furnish concrete of proper consistency and specified strengths.
   2. Provide concrete of the strengths indicated in the structural general notes.

B. COLOR MATERIALS
   1. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[free of carbon black, nonfading, and resistant to lime and other alkalis.

2. Integral Color: Integrally color concrete in colors, blending mixtures and application rates necessary to create colors, gradations, and variations to match Owner's Authorized Representative's mock-up.
3. Manufacturers:
   a. Trademark Concrete Systems
   b. Davis Colors.

C. Paving Types:
1. Concrete Paving Type 1: Refer to Landscape Construction Schedule and Plan.
2. Concrete Paving Type 2: Refer to Landscape Construction Schedule and Plan.
3. Concrete Paving Type 3: Refer to Landscape Construction Schedule and Plan.
4. Concrete Paving Type 4: Refer to Landscape Construction Schedule and Plan.
5. Concrete Paving Type 5: Refer to Landscape Construction Schedule and Plan.

2.03 SEALER

A. Clear siloxane or silane penetrating sealer. Acceptable products include, but not limited to:
1. "Pentane"
2. "Weather Worker J-26 WB"

2.04 SURFACE RETARDER

A. Surface retarder: shall be liquid compound that delays surface hydration of concrete surface, such as Topcast Surface Retarder, by Grace Products, distributed by Innovative Concrete; (949)498- 7077, or approved equal.

2.05 OTHER MATERIALS

A. JOINT MATERIALS
1. Expansion Material: Premoulded material, 3/8" thick, depth as required by slab, of resilient, non-bituminous material.
2. Joint Sealant: A one part moisture curing polyurethane sealant designed for caulking applications of exterior horizontal joints. Self-leveling and compatible for uses with the expansion material. Color to match adjacent paving.
   a. Acceptable manufacturers include:
      1) Polytite
      2) Tremco
      3) Sonneborn

B. REINFORCING MATERIALS
1. Welded Wire Fabric: 6 x 6 x W4.0 x W4.0 conforming to ASTM A 185. Furnished in flat sheets, not rolls, unless otherwise accepted by the University's Representative.
2. Steel Bars: Grade 40 or 60 billet steel conforming to ASTM A 626/615M. Bending process shall conform to the Manual of Standard Practice of the Concrete Reinforcing Steel Institute. Kinked bars shall not be used.

3. Dowels: Speed Dowels or equal

C. Forms:
1. Either steel or wood, of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are free of distortion and defects.
2. Flexible spring steel forms, laminated boards, or bender boards to form radius bends as required. (No transfer of form irregular surfaces is acceptable)
3. Form Release Agent: A non-staining form release compound that will not discolor or deface the surface of the concrete.

PART 3 - EXECUTION

3.01 PREPARATION

A. General: Examine the site and verify that no defects or errors are present that would cause defective installation or latent defects in the workmanship and function. Report unsatisfactory conditions to the University's Representative. Do not begin paving work until unsatisfactory conditions have been corrected and the area is ready to receive the work. Continuing with the installation constitutes acceptance of the unsatisfactory conditions and responsibility for satisfactory performance.
1. Subgrade Preparation: Unless noted otherwise, subgrades shall be compacted to a relative density as specified in the soils report, and to elevations necessary to achieve the finished surface indicated. Semi-porous subgrades shall be sprinkled sufficiently with water to eliminate suction and extremely porous subgrades shall be sealed in an approved manner.
2. Base Preparation: Where indicated, aggregate base material shall be deposited at a uniform quantity that will provide the required compacted thickness within ¼" above or below the grade determined from the Drawings. The relative compaction of the base material shall not be less than specified in the soils report. Compacted areas that do not conform to the requirements specified, shall be reworked, watered, and thoroughly re- compacted to conform to the specified requirements.
3. Coordinate with other trades, placement of accessories, chases, and other embedded items. Provide sufficient time to complete installation of their work.

B. Formwork: Shall conform to the shape, lines, and dimensions as called for on the Drawings.
1. Horizontal Tolerances: Formwork shall be constructed to assure the top of the form will not vary more than 1/8" in 10 feet along a straight edge.
2. Vertical Tolerances: Vertical faces shall not vary more than 1/8" in 10 feet along a straight edge.
3. Joints and Corners: Construct forms such that joint occur at approved locations. Form intersecting planes to provide true, crisp corner, with no edge grain of forms exposed to face of concrete. Construct exposed corners to produce smooth, solid, unbroken lines. Provide means to seal forms at joints and corners.

4. Completed formwork shall be free of hardened concrete, washed clean and shall have excess water removed, reinforcement secured in place, expansion joint material and other embedded items positioned, forms shall be thoroughly cleaned, washed out with water, and made tight. Before reinforcing steel is placed on top of or adjacent to forms that have been sealed, the surface sealer shall be wiped off so that none may be tracked over, or in any way come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.
5. Forms shall have been completed, and the entire preparation approved one (1) working day prior to the placing of concrete.

C. Reinforcing: Sized and placed where indicated on the Drawings as indicated by Civil details.
1. Wire Mesh: Panels shall be spliced not less than two (2) mesh openings, and shall be in placed on (1) working day prior to placing concrete. While the concrete is still plastic, the mesh shall be carefully lifted into position as specified on the Drawings.
2. Reinforcing Bars: Bars shall be place in accordance with the size and spacing shown of the Drawings. The bars shall be firmly and securely wired together and held in place with concrete or metal chairs. The complete work shall be in place and approve a minimum of one (1) working day prior to placing of concrete.

3.02 CONCRETE PLACEMENT AND FINISHES

A. Conveying Equipment:
1. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods that will prevent separation or loss of ingredients.
2. Conveying equipment shall be of size and design to ensure a continuous flow of concrete at the delivery end. The inner surfaces of the conveying equipment shall be free of hardened concrete and foreign materials.
3. Concrete shall be deposited continuously, or layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams, planes, or weakness within the section, or visible pour lines in the finish surface.
4. Concrete shall be consolidated by spading, rodding, or forking, so that the concrete is thoroughly worked around the reinforcement and into corners of forms, eliminating air or stone pockets which may cause honeycombing, pitting or planes of weakness.
5. At the end of a work day, or when more than two hours may elapse between concrete pours, installation shall terminate at an expansion joint or other transition as shown on the Drawings.
6. Removal of Forms: The supporting forms shall not be disturbed until the concrete has hardened sufficiently to permit their removal with safety.

B. CONCRETE FINISHING
1. Edge forms and intermediate screed strips shall be set accurately to produce the elevations and contours in the finished surface.

2. After placing concrete, tamp with heavy grille tamper until at least 3/8" of mortar has been brought to the surface, as soon as the surface becomes workable, push down all coarse aggregate, filling all holes and leveling surface to a true and even surface.
3. Sand Finish:
   a. Sand finish paving to match approved mock up. Expose fine aggregate with no exposure of course aggregate – 1/16" reveal.
   b. Ensure that paving surfaces receiving sand finish are hand trowelled before final concrete set.
   c. Wrap adjacent improvements that may be etched during operations such as metal work, stone, plant material, etc.
   d. Apply topcast with sprayer per manufacturer's instructions.
   e. Note Manufacturer's recommendations on light etches.
   f. Wash concrete to remove topcast.
   g. Use water for clean up.
   h. Finishes shall have uniform color and texture over entire area. Surfaces shall be free of ruts, grooves, dimples, or swirl marks resulting from etching or washing procedures.
   i. Edges shall be crisp and true to lines and have finishes consistent with the field.
4. Medium Washed Aggregate Finish:
   a. Washed Aggregate Finish paving to match approved mock up. Expose coarse aggregate to 3/16" or more as determined by field mock-up.
   b. Wrap adjacent improvements that may be etched during operations such as metal work, stone, plant material, etc.
   c. Apply topcast with sprayer per manufacturer's instructions.
   d. Note Manufacturer's recommendations on light etches.
   e. Wash concrete to remove topcast.
   f. Use water for clean up.
   g. Finishes shall have uniform color and texture over entire area. Surfaces shall be free of ruts, grooves, dimples, or swirl marks resulting from etching or washing procedures.

C. Joints in Concrete: Locate as indicated on the Drawings.
1. Expansion Joints: Expansion material shall be placed at the appropriate elevation to achieve the depth of the sealant indicated on the Drawings. The top of the finished sealant shall be between 1/8" and 1/4" below the finished surface.
2. Saw Cut Scorelines: The saw shall be fitted with diamond blades. Joints shall be a wet saw cut, applied within 24 hours of placing the concrete. Joints shall meet the size and depth indicated on the Drawings and the completed groove at the finished surface shall not vary more than 1/32" of the width indicated.
3. Tooled Edges: The joints shall be constructed to the size and depth indicated on the Drawings. Joints shall be true to the lines and shapes shown on the Drawings, and shall not vary more than 1/16" from true. Grooves shall be smooth, uniform, and to the size and dimension indicated on the Drawings.

4. Joint Sealant: Prior to applying the sealant, the joints shall be cleaned of all mortar, laitance, scale, dirt, dust, oil, curing compound and other foreign materials. The joints and adjacent surfaces shall be dry and where called for by the manufacturer, prepared with a primer. The joints shall be filled from bottom to top without voids. All adjoining surfaces shall be protected during the sealing operations and all stains, marks, and damage resulting from the sealant operations shall be corrected.

D. Protection and Curing: Provide and apply a sheet curing material that conforms to ASTM C 171, Standard Specifications for Sheet Material Curing Concrete. Protect concrete from defacement. All defaced concrete shall be replaced between expansion joints at no additional expense to the Owner.

E. Sealers: Prepare the finished surface and apply the penetrating sealer as recommended by the manufacturer.

END OF SECTION

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Chain-link fences.
   2. Horizontal-slide gates.

B. Related Sections:
   1. Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" for cast-in-place concrete post footings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Fence and gate posts, rails, and fittings.
      b. Chain-link fabric, reinforcements, and attachments.
      c. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include accessories, hardware, gate operation, and operational clearances.

C. Design Data Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the professional engineer responsible for their preparation.

1.03 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hoover Fence Company.
   2. Master Halco, Inc.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
   1. Design Wind Load: As indicated on Drawings.
      a. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

2.03 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
   1. Fabric Height: As indicated on Drawings.
   2. Steel Wire for Fabric: Wire diameter of 0.148 inch , unless indicated otherwise.
      a. Mesh Size: 2 inches, unless indicated otherwise.
      b. Zinc-Coated Fabric: ASTM A392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before weaving.
   3. Selvage: Knuckled at both selvages.

2.04 FENCE FRAMEWORK

A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:
   1. Fence Height: As indicated on Drawings.
   2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40 orGroup IC, round steel pipe, electric-resistance-welded pipe.
   3. Horizontal Framework Members: ASTM F1043.
   4. Brace Rails: ASTM F1043.
   5. Metallic Coating for Steel Framework:
      a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.
      b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
      c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- thick, zinc-pigmented coating.
      d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.
      e. Coatings: Any coating above.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.05 HORIZONTAL-SLIDE GATES

A. General: ASTM F1184 for gate posts and single sliding gate types.

B. Pipe and Tubing:
1. Zinc-Coated Steel: Protective coating and finish to match fence framework.
2. Gate Posts: ASTM F1184. Provide round tubular steel posts.
3. Gate Frames and Bracing: Round tubular steel .

C. Frame Corner Construction: Welded.

D. Hardware:
1. Hangers, Roller Assemblies, and Stops: Fabricated from galvanized steel.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

2.06 FITTINGS

A. Provide fittings according to ASTM F626.

B. Finish:
1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

PART 3 - EXECUTION

3.01 EXAMINATION

3.02 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

C. Chain-Link Fabric: Apply fabric to enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

D. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.
   1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

E. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

3.03 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.04 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 32 31 19.55 - DECORATIVE METAL SECURITY GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Decorative metal security gates.

B. Related Sections:
   1. Division 03 Section "Cast-in-Place Concrete" for concrete footings.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For gates.
   1. Include plans, elevations, sections, gate locations, post spacing, andmounting details.

1.03 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 DECORATIVE METAL SECURITY GATES

A. Decorative Metal Gates:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Ametco Manufacturing Corp.
      b. A&T Iron Works, Inc.
      c. Fortress Building Products.
      d. Omega II Fence Systems.

B. Galvanizing: For components indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

C. Finish: Powder coating.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.02 SWING GATES

A. Gate Configuration: As indicated.

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes formed from minimum 0.105-inch nominal-thickness steel and hot-dip galvanized after fabrication.

E. Frame Construction: Welded.

F. Infill: Match adjacent fence.

G. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

H. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

I. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch-diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

J. Finish exposed welds to comply with NOMMA Guideline 1, Finish #3 - partially dressed weld with splatter removed.

K. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

2.03 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A36/A36M.

B. Tubing: ASTM A500/A500M, cold-formed steel tubing.

C. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A1011/A1011M, Structural Steel, Grade 45 or cold-rolled steel sheet, ASTM A1008/A1008M, Structural Steel, Grade 50.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

2.04 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

2.05 METALLIC-COATED-STEEL FINISHES

A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

B. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a zinc-phosphate conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A780/A780M.

C. Powder Coating: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat finish consisting of epoxy prime coat and TGIC polyester topcoat to a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of 4 mils.
1. Color and Gloss: Match Architect's sample.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.

3.03 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION

MasterSpec Copyright © 2023 by the American Institute of Architects, portions Copyright © 2023 by HMC Architects for Arroyo HS New Construction - Package 2. Warning: This AIA MasterSpec based document is protected by U.S. Copyright Law and International Treaties.

SECTION 32 84 00 – LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. General: This Section includes the Irrigation System in accordance with Contract Documents.

B. Summary of Work: Provide all labor, equipment and materials required to procure and install the irrigation system, complete, as indicated on Drawings and as specified herein.

C. Refer to specification section 01 81 13 for LEED credits

1.2 SUBMITTALS

A. Materials List:

1. Contractor shall furnish the articles, equipment, materials, or processes specified by name on Drawings and in Specifications. No substitution will be allowed without prior written approval by Landscape Architect.
2. Complete Materials List shall be submitted prior to performing any work. Materials List shall include the manufacturer, model number, and description of all materials and equipment to be used.
3. Although manufacturer and other information may be different, the following is a guide to proper submittal format:

Item No.	Description	Manufacturer	Model No.
1	Back Flow Preventer	FEBCO	825YA
2	Master Valve	SUPERIOR	3100
3	Flow Sensor	FLOMEC	QS-200
4	Automatic Controller	HUNTER	A2C-2400-SS
5	Remote Control Valve	HUNTER	IBV-101-FS
6	Quick Coupler Valve	HUNTER	HQ-44LRC
7	Shut Off Valve	NIBCO	T-111
8	Etc.	<Etc.>	<Etc.>

4. Irrigation submittal must be specific and complete. All items must be listed and shall include solvent/primer, wire, wire connectors, valve boxes, etc. Copies of manufacturers' literature (catalog cuts) are not required as submittal information.
5. Contractor may submit substitutions for equipment and materials listed on the Irrigation Drawings by following procedures as outlined in Article 1.5 of these Specifications.

6. Equipment or materials installed or furnished without prior approval of Landscape Architect may be rejected and Contractor may be required to remove such materials from the site at his own expense.
7. Approval of any item, alternative or substitute indicates only that the product or products apparently meet the requirements of Drawings and Specifications on the basis of the information or samples submitted.
8. Manufacturers' warranties shall not relieve Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.

B. Record Drawings:
1. Contractor shall provide and keep up-to-date a complete record set of prints which shall be corrected daily, showing every change from the original Drawings and Specifications and the exact installed locations, sizes, and kinds of equipment. Prints for this purpose may be obtained from Landscape Architect at cost. This set of Drawings shall be kept on the site and shall be used only as a record set.
2. These Drawings shall also serve as work progress sheets and shall be the basis for measurement and payment for work completed. These Drawings shall be available at all times for observation and shall be kept in a location designated by Landscape Architect. Should the record blueline drawing progress sheets not be available for review or not be up-to-date at the time of any observation (refer to Article 3.10, Site Observation Schedule below), it will be assumed no work has been completed and Contractor will be assessed the cost of that site visit at the current billing rate of Landscape Architect. No other observations shall take place prior to payment of that assessment.
3. Contractor shall make neat and legible notations on their record drawing progress sheets daily as the work proceeds, showing the work as actually installed. For example, should a piece of equipment be installed in a location that does not match the plan, Contractor must indicate that equipment has been relocated in a graphic manner so as to match the original symbols as indicated in the Irrigation Legend. The relocated equipment and dimensions will then be transferred to the original record drawing plan at the proper time.
4. Before start of Landscape Maintenance, Contractor shall provide the completed irrigation red lined set of "As-Built" Record Drawings to Landscape Architect for review and approval. After review and approval of the red lined set of "As-Built" Record Drawings by Owner, "As-Built" information shall be transferred to AutoCAD electronic drawing files. Electronic files of irrigation system will be provided by Owner. Dimensions shall be made so as to be legible even on the final Controller Chart. Provide AutoCAD submittal plot for Landscape Architect's review and approval prior to fabricating the Controller Charts. Update AutoCAD electronic files of "As-Built" Record Drawings in accord with Landscape Architect's requirements.
5. Contractor shall be responsible for preparation of irrigation "As-Built" Record Drawings in AutoCAD format. Contractor shall pay all costs involved for preparation of the irrigation "As-Built" Record Drawings in AutoCAD format. This cost shall be included as a part of Contractor's bid and no additional compensation shall be paid to Contractor by Owner.
6. Contractor shall dimension from 2 permanent points of reference, such as building corners, sidewalk edges, road intersections, etc., the location of the following items:

a. Connection to existing water lines.
b. Connection to existing electrical power.
c. Gate valves.
d. Routing of irrigation pressure lines (dimension max. 100 feet along routing and at each change of direction).
e. Location of additional sleeves/conduits.
f. Electric control valves.
g. Routing of control wiring.
h. Quick coupling valves.
i. Other related equipment as directed by Landscape Architect.

7. Prior to the start of maintenance, Contractor shall deliver full-size bond plot(s) of Landscape Architect-reviewed, corrected and completed AutoCAD computer plots of "As-Built" Record Drawings along with AutoCAD electronic files on compact disk, to Owner as part of Contract closeout. Delivery of plots will not relieve Contractor of the responsibility of furnishing required information that may have been omitted from the prints.

C. Controller Charts:
1. “As-Built” Record Drawings shall be reviewed by Landscape Architect before Controller Charts are prepared.
2. Provide 2 Controller Charts for each controller supplied.
3. The chart shall show the area controlled by the automatic controller and shall be the maximum size, which the controller door will allow.
4. The chart is to be a reduced drawing of the actual installed system. However, in the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a size that will be readable.
5. The chart shall be a blackline print and a different color shall be used to indicate the area of coverage for each station.
6. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 10 mils.
7. These charts shall be completed and approved prior to the Final Field Observation of the irrigation system.

D. Operation and Maintenance Manuals:
1. Prepare and deliver to Landscape Architect within 10 calendar days prior to completion of construction, 2 Maintenance Manuals in hardcover, three-ring binders containing the following information:
a. Index sheet which states Contractor's name, address, and telephone number, and which lists each installed equipment and material item, including names and addresses of manufacturers' local representatives.
b. Catalog and parts sheets on every material and equipment item installed under this Contract.
c. Complete operating and maintenance instructions on all major equipment.
d. Guarantee statement.

2. In addition to the above-mentioned Maintenance Manuals provide Owner's Maintenance Personnel with instructions for major equipment and show evidence in writing to Landscape Architect at the conclusion of the project that this service has been rendered.

E. Equipment to be Furnished:
   1. Supply as a part of this contract the following tools:
      a. One (1) set of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
      b. A minimum of two (2) five-foot keys for operation of gate valves. Provide 2 keys for each type of operating device (2-inch operating nut, cross handle, etc.).
      c. Two (2) keys for each automatic controller.
      d. One (1) quick coupler key and matching hose swivel for every 5 or fraction thereof of each type of quick coupling valve installed.
      e. Operation and maintenance manuals.
      f. Automatic controller and other central computer control components certification letter from manufacturer for each automatic controller and other central control components installed under this contract.
      g. Central irrigation computer control system manuals for any components installed under this contract.
      h. Two (2) color-coded Controller Charts laminated between two (2) pieces of 10 mil plastic each – Provide two (2) charts for each controller.
      i. “As-Built” Record Drawing per this Specification Section.
      j. Irrigation booster pump certification and warranty information.
      k. Completed Irrigation Guarantee Statement.
      l. Electric utility company billing information. (If required)
      m. Water district billing and water meter information. (If required)
      n. Water district recycled water cross connection contamination certification
      o. Health department Cross Connection certification.
      p. Acceptance document to be signed by Landscape Architect.
   2. Drip Spare Parts:
      a. Two (2) Plastic handled punch.
      b. 500 feet of dripper tubing for each dripper interval and discharge rate.
      c. 25 barbed couplings.
      d. 25 barbed 90-degree elbows fittings.
      e. 25 barbed tee fittings.
      f. 180-degree two-way adapter tees.
      g. 25 male adapters with 3/4 inch FPT.
      h. Five (5) spare filter element of the mesh size indicated on the Irrigation Legend.
      i. Five (5) line-flushing valves.
      j. 10 regulator springs of the colored and regulating pressure indicated on the Irrigation Legend.
      k. 25 dripper plug rings.

3. The above-mentioned equipment shall be turned over to Owner prior to start of landscape maintenance. Before landscape maintenance and final observation to start can occur, evidence that Owner has received these items must be shown to Landscape Architect. Refer to Article 1.12, Turnover and Acceptance Form in this Specification for additional information.

F. Checklist:
1. Complete the following checklist at the end of each segment of the project, using the format shown and on the forms provided:
   a. Plumbing permits: If none required, so state.
   b. Materials approvals.
   c. Pressure line tests: By whom approved and date.
   d. Materials furnished: Recipient and date.
   e. Manufacturers' warranties, if required: Recipient and date.
   f. Written guarantee: Recipient and date.
   g. Lowering of heads in lawn areas: If not complete, so state and include anticipated completion date.
   h. Install anti-drain valve protection as required to prevent low head drainage.
2. The checklist for the irrigation system information shall be submitted and filed with Owner prior to start of the next segment of work in the construction sequence.

1.3 QUALITY ASSURANCE & REQUIREMENTS

A. Permits and Fees: Contractor shall obtain and pay for any and all permits and all inspections required by permits.

B. Manufacturers' Directions: Manufacturers' directions and detailed drawings shall be followed in all cases where the manufacturers of articles used in this Contract furnish directions covering points not indicated on Drawings and in Specifications.

C. Ordinances and Regulations: All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these Specifications and their provisions shall be carried out by Contractor. Anything contained in these Specifications shall not be construed to conflict with any of the above rules, regulations, or requirements. However, when these Specifications and Drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, the provisions of these Specifications and Drawings shall take precedence.

D. Explanation of Drawings.
1. Due to the scale of Drawings, it is not possible to indicate all offsets, fittings, sleeves, etc., which may be required. Contractor shall carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in

such a manner as to avoid conflicts between the irrigation system, planting, utilities and architectural features.

2. All work called for on Drawings by notes or details shall be furnished and installed whether or not specifically mentioned in Specifications.
3. Contractor shall not install the irrigation system as indicated on Drawings when obstructions, grade differences, or discrepancies in area dimensions exist that might not have been considered in engineering. Such obstructions or differences should be brought to the attention of Landscape Architect. In the event this notification is not performed, Contractor shall assume full responsibility for any revision necessary.

E. Reference Specifications and Standards.
1. ASTM: D1784 Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated.
2. ASTM: D1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and CL200.
3. ASTM: F441 Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40, 80 and CL200.
4. ASTM: 2464 Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
5. ASTM: F437 Threaded Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
6. ASTM: D2466 Socket-Type Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM: F438 Socket-Type Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.
8. ASTM: 2564 Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.
9. ASTM: F493 Solvent Cements for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe and Fittings.

F. Qualifications: Contractor and its on-site job superintendent shall have regularly engaged and specialized, for the preceding 5 years, in the installation of irrigation systems of similar scope, size and complexity as the system being installed under this contract.
1. Potable water piping from the point of connection to the backflow device shall be installed by a firm licensed to perform this work.
2. Non-Potable water piping from the point of connection to the irrigation water meter shall be installed by a firm licensed to perform this work.
3. Electrical power (110 volts & above) shall be installed by a firm licensed to perform this work.
4. Demonstrate completion of the manufacturer’s installation certification program for the computer-controlled irrigation system.
5. Upon Owner’s request, supply a list of references listing successfully completed commercial computer-controlled irrigation systems

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handling of PVC Pipe and Fittings: Contractor is cautioned to exercise care in handling, loading, unloading, and storing PVC pipe and fittings. All PVC pipe shall be transported in a vehicle, which allows the length of pipe to lie flat so as not to subject it to undue bending

or a concentrated external load at any point. Any section of pipe that has been dented or damaged will be discarded, and if installed, shall be replaced with new piping at no additional cost to the Owner.

1.5 SUBSTITUTIONS

A. If Contractor wishes to substitute any equipment or materials for the equipment or materials listed on Drawings and in Specifications, they may do so by providing the following information to Landscape Architect for review.
   1. Provide a statement indicating the reason for making the substitution. Use a separate sheet of paper for each item to be substituted.
   2. Provide descriptive catalog literature, performance charts and flow charts for each item to be substituted.
   3. Provide the amount of cost savings if the substituted item is approved.

B. Landscape Architect shall have the sole responsibility in accepting or rejecting any substituted item as an approved equal to the equipment and materials listed on Drawings and in Specifications.

1.6 BACKFLOW REGISTRATION

A. Provide a Backflow Report Form completed by a Certified Backflow Tester. The test shall be done in the presence of District Inspector. A copy of the Backflow Report Form shall be submitted to the District Inspector

1.7 PROJECT CONDITIONS

A. Owner reserves the right to make temporary repairs as necessary to keep the irrigation system equipment in operating condition. This in no way alters the requirements of Contract Documents.

B. Coordinate Work with that of other trades, all underground improvements, the location and planting of specimen trees and all other planting. Verify location of all planting that requires excavations 24 inches in diameter and larger with the general contractor prior to installation of irrigation main lines.

C. Provide temporary irrigation at all times to maintain plant materials. All temporary irrigation shall remain unless specifically directed to be removed by Landscape Architect

1.8 SEQUENCING AND SCHEDULING

A. Acceptance: Do not install main line trenching prior to acceptance by Landscape Architect of rough grades completed under another Section.

B. Coordination: Coordinate with the work of other sections to insure the following sequence of events.

1. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving (and through walls and footings) prior to placement of those materials.
2. Bubbler Heads in Tree Planter Pockets: Install after placement of tree, but prior to backfill with planter soil mix.
3. Reclaimed water valve and main line trenching and installation of sleeving to allow for appropriate construction sequencing to comply with all Health Code requirements relative to horizontal and vertical clearances from potable water lines.

1.9 MAINTENANCE

A. Maintenance: Inspect and adjust all spray valves and control valves including raising or lowering of spray valve heights to accommodate plant growth, to achieve uniform irrigation at all times. Verify correct operating pressure.

B. Controller Maintenance: Inspect regularly for power interruption and reset clock as required. Adjust station timing to accommodate changes in plant growth.

C. Drip Irrigation Maintenance: All of above plus keep strainer clean. Flush lines as required. Inspect emitters for proper flow, and check moisture level at plant root ball weekly for the first month of operation and monthly thereafter.

D. System Failure: Perform all repairs within 1 operating period. Replacements shall match removed products and materials in all respects. Report promptly all damage not resulting from Contractor's operations. Repair all damage caused by Contractor at no expense to Owner.

E. Weather Change: Do not run the irrigation system during the rainy season. Set and program automatic controllers in response to seasonal requirements and requirements of newly planted materials.

1.10 GUARANTEE

A. The guarantee for the irrigation system shall be made in accordance with the attached form. The General Conditions and Supplementary Conditions of these Specifications shall be submitted and filed with Owner prior to acceptance of the irrigation system.

B. A copy of the guarantee form shall be included in the operations and maintenance manual.

C. The guarantee form shall be re-typed on Contractor's letterhead and shall contain the following information:

GUARANTEE FOR IRRIGATION SYSTEM

We hereby guarantee that the irrigation system we have furnished and installed for the Project is free from defects in materials and workmanship, and the work has been completed in accordance with Drawings and Specifications, ordinary wear and tear and

unusual abuse, or neglect expected. We agree to repair or replace any defects in material or workmanship which may develop during the period of one (1) year from date of acceptance and also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to Owner. We shall make such repairs or replacements within a reasonable time, as determined by Owner, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of such written notice from Owner, we authorize Owner to proceed to have said repairs or replacements made at our expense and we will pay for the costs and charges therefore upon demand.

PROJECT:

LOCATION:

SIGNED:

ADDRESS:

TELEPHONE:

DATE OF ACCEPTANCE:

1.11 TURNOVER TO OWNER

The following checklist, turnover and acceptance forms shall be re-typed on Contractor's letterhead. The form shall be completed by Contractor and shall contain the all of the information shown on this sample checklist form and turned over to Owner prior to start of maintenance:

TURNOVER AND ACCEPTANCE FORM

PROJECT: _____

LOCATION: _____

TURNOVER ITEMS:

- ☐ Operation and Maintenance Manuals.
- ☐ Automatic Controller Certification Letter for each Calsense automatic controller installed under this contract.
- ☐ Two (2) keys for each automatic controller.
- ☐ One (1) set of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
- ☐ A minimum of one (1) five-foot key for operation of gate valves. Provide one (1) key for each type of operating device (2-inch operating nut, cross handle, etc.).
- ☐ Two (2) quick coupler keys and matching hose swivel for each type of quick coupling valve installed.

- ☐ Irrigation Controller Manuals.
- ☐ Color-Coded Controller Charts laminated between 2 pieces of 10 mil plastic each – Provide two (2) charts for each Controller.
- ☐ "As-Built" Record Drawings per this Irrigation Specification.
- ☐ Completed Irrigation Guarantee Statement.

DELIVERED BY:	ACCEPTED BY:
_____ Name of Contractor	_____ Name of Owner
_____ Name of Contractor's Authorized Representative	_____ Name of Owner's Authorized Representative
_____ Signature of Contractor's Authorized Representative	_____ Signature of Owner's Authorized Representative
_____ Date of Delivery to Owner	_____ Date of Acceptance by Owner's Authorized Representative

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Use only new materials of brands and types noted on Drawings and as specified herein, or approved equals.

B. PVC Pressure Main Line Pipe and Fittings:
   1. Pressure main line piping for sizes 2-inch and larger shall be PVC SCH 40.
   2. Class 315 pipe shall be made from an NSF approved Type I, Grade I, PVC compound conforming to ASTM resin specification D1784. All pipe must meet requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension (S.D.R.) (Solvent-weld Pipe).
   3. Pressure main line piping for sizes 1-1/2 inches and smaller shall be PVC Schedule 40 with solvent welded joints.
   4. Schedule 40 pipe shall be made from NSF approved Type I, Grade I PVC compound conforming to ASTM resin specification D1785. All pipe must meet requirements as set forth in Federal Specification PS-21-70.
   5. PVC solvent-weld fittings shall be Schedule 40, 1-2, II-I NSF approved, conforming to ASTM test procedure D2466.

6. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods prescribed by the manufacturer.
7. All PVC pipe must bear the following markings:
   a. Manufacturer's name
   b. Nominal pipe size
   c. Schedule or class
   d. Pressure rating in P.S.I.
   e. NSF (National Sanitation Foundation) approval
   f. Date of extrusion
8. All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable I.P.S. schedule and NSF seal of approval.
9. Color to be purple to denote reclaimed water, if applicable.
10. Refer to sheet 14-100 for additional notes relative to Health Code requirements.

C. PVC Non-Pressure Lateral Line Pipe and Fittings
1. Non-pressure buried lateral line piping shall be PVC Schedule 40 with solvent-weld joints when installed in planting areas. Minimum pipe size shall be 3/4-inch diameter.
2. Non-pressure lateral line piping installed under paved areas shall be PVC Schedule 40 with solvent welded joints. Minimum pipe size shall be 3/4-inch diameter.
3. Pipe shall be made from NSF approved, Type I, Grade II PVC compound conforming to ASTM resin specification D1784. All pipe must meet requirements set forth in Federal Specification PS-22-70 with an appropriate standard dimension ratio.
4. Except as noted in Paragraphs 1, 2, and 3 of this Article 2.1 C of these Specifications, all requirements for non-pressure lateral line pipe and fittings shall be the same as for solvent-weld pressure main line pipe and fittings as set forth in Article 2.1 B of these Specifications.
5. Color to be purple to denote reclaimed water, if applicable.
6. Refer to sheet 14-100 for additional notes relative to Health Code requirements.

D. Brass Pipe and Fittings:
1. Where indicated on Drawings, use red brass screwed pipe conforming to Federal Specification #WW-P-351.
2. Fittings shall be red brass conforming to Federal Specification #WW-P-460.

E. Copper Pipe and Fittings:
1. Pipe: Type K, hard tempered. See plans for locations.
2. Fittings: Wrought copper, solder joint type.
3. Joints shall be soldered with silver solder, 45% silver, 15%copper, 16% zinc, 24% cadmium, solidus at 1125 degrees F. and liquidus at 1145 degrees F.

F. Isolation Valve:
1. Ball valves 3-inch and smaller shall meet the following requirements:
   a. Ball valve shall be size and type as indicated on Drawings.
   b. Ball valve shall be similar to those manufactured by Lasco or approved equal.

2. All gate valves shall be installed per installation details.

G. Quick Coupling Valve:
   1. Quick coupling valves shall have a brass, two-piece body designed for working pressure of 150 P.S.I.
   2. Quick coupling valve shall be operable with a quick coupler key. Key size and type shall be as indicated on Drawings.

H. Check Valve:
   1. Swing check valves 2-inch and smaller shall be 200-pound W.O.G. bronze construction with replaceable composition, neoprene, or rubber disc and shall meet or exceed Federal Specification WW-V-51D, Class A, Type IV.
   2. Anti-drain valves shall be of heavy-duty virgin PVC construction with F.P.T. thread inlet and outlet. Internal parts shall be stainless steel and neoprene. Anti-drain valve shall be field adjustable against draw out from 4 to 32 feet of head. Anti-drain valve shall be similar to the Hunter HCV, or approved equal.

I. Control Wiring:
   1. Wire requirements are as follows:
      a. 12 gauge colored wire. Control wires to be red and common wire to be white.
      b. Flow sensor wire to be shielded wire.
      c. Unless otherwise noted, connections between an automatic controller and its corresponding electric control valves shall be made with direct burial copper wire AWG-U.F. 600-volt.
      d. Control wires shall be a different color wire for each automatic controller. Common wires shall be white with a different color stripe for each automatic controller. Color of stripe shall match color of control wires. Spare wire shall be a different color than the control wire color.
      e. Install in accordance with valve manufacturer's specifications and wire chart. In no case shall wire size be less than #14 for control wires and #14 for common wires.
      f. Provide separate control and common wires for operation of each automatic gate valve. Install wires within the same conduit as its related flow sensor cable.
   2. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible.
   3. Where more than 1 wire is placed in a trench, the wiring shall be taped together at intervals of 10 feet.
   4. An expansion curl shall be provided within 3 feet of each wire connection. Expansion curl shall be of sufficient length at each splice connection at each electric control valve, so that in case of repair, the valve bonnet may be brought to the surface without disconnecting the control wires. Control wires shall be laid loosely in trench without stress or stretching wire conductors.
   5. All splices within shall be made with, 3M "DBY" direct bury splice kits or approved equal. Make only one splice with each connector.
   6. Field splices between the automatic controller and electric control valves will not be allowed without prior approval of Landscape Architect.

J. Automatic Controller:
   1. Automatic controller(s) shall be of size and type as indicated on Drawings.
   2. Final location of automatic controller(s) shall be approved by Landscape Architect.
   3. Unless otherwise noted on Drawings, the 120-volt electrical power to each automatic controller location is to be furnished by a contractor licensed to perform this work. The final electrical hook-up shall be the responsibility of Contractor.
   4. Each automatic irrigation controller shall be included as a component part of the specified stainless steel vandal-resistant controller enclosure assembly. See Article 2.1 Q of these Specifications for additional information.

K. Valve Box:
   1. All valve boxes shall be black in color and have a black lid with recycled water identification embossed.
   2. Use 10-inch x 10-1/4-inch round box for all gate valves, NDS with black bolt-down cover or approved equal. Extension sleeve shall be PVC with minimum size of 6 inches.
   3. Use 11-3/4-inch x 17-inch x 11-inch rectangular box for all electric control valves, NDS with black bolt-down cover.
   4. Use 10-inch diameter x 10-1/4-inch deep round plastic valve box for all quick coupling valves, NDS with black bolt-down cover.

L. Sprinkler Head:
   1. All sprinkler heads shall be of the same size, type, and deliver the same rate of precipitation with the diameter (or radius) of throw, pressure, and discharge as indicated on Drawings and/or as specified herein.
   2. Spray heads shall have a screw adjustment.
   3. Riser units shall be fabricated in accordance with the installation details.
   4. Riser nipples for all sprinkler heads shall be the same size as the riser opening in the sprinkler body.
   5. All sprinkler heads of the same type shall be by the same manufacturer.

M. Identification Tags:
   1. Identification tags for electric control valves shall be manufactured from Polyurethane Behr Desopan. Use Christy's (or approved equal) standard tag hot-stamped with black letters on purple background. Tags shall be numbered to match programming as indicated on Drawings. Provide one tag for each electric control valve. Color of tags shall comply with local Health Codes to be purple or yellow in color to denote reclaimed water.
   2. Special order tags from T. Christy Enterprises, 655 East Ball Road, Anaheim, California 92805. Tel: (714) 507-3300.

N. Sub-Surface Drip Irrigation System:
   1. Drip tubing shall be of nominal sized one-half inch low density, ultra-violet-resistant, linear polyethylene tubing with internal pressure-compensating, self-cleaning, integral drippers at a specified interval. The tubing shall be brown with purple stripe for use in

reclaimed water systems and shall conform to an outside diameter (O.D.) of 0.710 inches and an inside (I.D.) diameter of 0.62 inches. The low volume tubing shall be capable of a discharge rate of 0.4 gallons per hour (GPH) between operating pressures of 7 to 70 psi for each individual dripper. Dripper tubing shall be sub-surface drip line as indicated on Drawings.

2. The individual self-cleaning, pressure-compensating drippers shall be welded to the inside of the tubing wall. The drippers are constructed of 3 individual pieces:
   a. Black-colored dripper containing a filtration system on the inlet side, compensation cell, and recessed chamber with a water outlet.
   b. Hard plastic diaphragm retainer (colored red (0.61) or black (0.92) depending on the discharge rate), with chamfered edges and a recessed groove in the center the full length of the diaphragm.
   c. Flexible black rubber diaphragm that allows excessive pressure to build up within the chamber to purge sediment or other debris that may not have been captured by the disc filter.
3. Spacing of Dripper shall be 12 inches on center.
4. All insert barbed fittings shall be constructed of molded, ultra-violet-resistant, brown-colored plastic having a nominal inside dimension (I.D.) of 0.57 inches (17 mm). Each fitting shall have a minimum of two ridges or barbs per outlet. All fittings shall be available in one of the following end configuration:
   a. Barbed insert fittings.
   b. Male pipe threads (MPT) with barbed insert fittings or female pipe threads (FPT) with barbed insert fittings.
5. Non-pressure supply and exhaust headers shall be Rain Bird QF header. Size as required.
6. The line-flushing valve shall be constructed of brown molded plastic and shall be a normally open hydraulic valve which flushes based on volumetric quantities of water. Inlet and outlet configurations shall be 1/2-inch MPT.
7. The line-flushing valve shall be serviceable by removing a threaded cover from a base, exposing the internal components. The internal components of the line-flushing valve shall consist of a molded diaphragm retainer, a high density plastic flush regulator, and a diaphragm 2 inches in diameter. The line-flushing valve shall be capable of automatically operating during initial system pressure build-up to discharge approximately one gallon of water per 15 gpm demand at 50 psi maximum, or 1.5 psi minimum inlet pressure.
8. Pressure regulation valve shall be a spring-operated piston type with an externally accessible regulation unit that can be serviced without removing the valve from the system. The valve shall be constructed from molded black plastic with 6 different colored tops with interchangeable springs denoting different pressure regulation and flow ranges. The regulator shall have a built-in indicator that shows when the proper outlet pressure is reached. Operating ranges for the valves shall be from 15 to 50 psi in 5 psi increments. Inlet and outlet ports of the valve shall be a combination of male/female threads.
9. The screen filter body shall be molded of black plastic with male pipe threads (MPT) for both the inlet and outlet ports. A threaded cap on one end of the body shall be

capable of periodic servicing by unscrewing the cap or releasing the latched band from the main filter body.

10. The filter elements shall be screen-type with 150 mesh filter.
11. Air/vacuum relief valves shall be constructed of gray plastic with an internal sliding poppet valve that is capable of venting air or vacuum to the atmosphere only. The main body shall have a 1/2-inch male pipe thread (MPT). Operating pressure range for the air/vacuum relief valve shall be 7 psi minimum to 140 psi maximum.
12. Tubing clamps shall be constructed to 304 AISI stainless steel and shall be one “ear” type. This “ear” shall be capable of being pinched with a pinching tool to secure the tubing around the insert barbed fitting. Interior clamp wall shall be smooth to prevent crimping or pinching of tubing. Wall thickness of clamps shall be .0236 inches (0.6 mm) with an overall band width of 1/4 inch (7 mm).

O. Backflow Prevention Unit:
   1. Coordinate all backflow locations with Landscape Architect.
   2. Provide a Backflow Report Form completed by a Certified Backflow Tester. The test shall be done in the presence of the Water District Inspector.

P. Irrigation Booster Pump:
   1. Irrigation booster pumps shall be as specified on the plans.
   2. Coordinate location and installation of pump assemblies with the Landscape Architect.
   3. Coordinate electrical connections with Electrical contractor.

Q. Miscellaneous Irrigation Equipment:
   1. See Drawings for sizes and types of miscellaneous irrigation equipment such as:
      a. Hunter Solar Sync Weather/Rain Sensor.
      b. Wifi Connection for controller.
   2. All miscellaneous irrigation equipment shall be as specified or approved equal

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Before work is commenced, hold a conference with Owner, General Contractor, and Landscape Architect to discuss general details of the work.

B. Verify dimensions and grades at job site before work is commenced.

C. During the progress of the work, an experienced superintendent and any assistants necessary shall be on site, all satisfactory to Owner. The superintendent shall not be changed, except with the written consent of Owner, unless that person proves unsatisfactory and ceases to be employed. The superintendent shall represent Contractor in its absence and all directions given to the superintendent shall be as binding as if given to Contractor.

D. All work indicated or noted on Drawings shall be provided whether or not specifically mentioned in these Specifications.

E. If there are ambiguities between Drawings and Specifications and specific interpretation or clarification is not issued prior to bidding, the interpretation or clarification will be made only by Landscape Architect. Contractor shall comply with Landscape Architect's interpretations. In the event the installation contradicts the directions given, the installation shall be corrected by Contractor at no additional cost to Owner.

F. Layout of sprinkler lines as indicated on Drawings is diagrammatic only. Location of sprinkler equipment is contingent upon and subject to integration with all other underground utilities. Contractor shall employ all data contained in the Contract Documents and shall verify this information at the construction site to confirm the manner by which it relates to the installation.

G. Coordinate the installation of all irrigation materials, including pipe with Landscape Planting Drawings to avoid conflict with the trees, shrubs or other planting.

H. Do not proceed with the installation of the irrigation system when it is apparent that obstructions or grade differences exist or if conflicts in construction details, legend, or specific notes are discovered. All such obstructions, conflicts, or discrepancies shall be brought to the attention of Landscape Architect.

I. Replace, or repair to the satisfaction of Landscape Architect, all existing paving disturbed during the course of this work. New paving shall be the same type, strength, texture, finish, and be equal in every way to the material removed.

J. Owner reserves the right to make temporary repairs as necessary to keep equipment in operating condition without voiding Contractor's guarantee or relieving Contractor of its responsibilities during the guarantee shall not be allowed.

K. In addition to any anti-drain devices specified on Drawings irrigation heads showing signs of drainage after the irrigation system has been operated from an on to off position will require installation of anti-drain devices to prevent low head drainage.

L. Prior to start of construction Contractor shall contact sub-surface representative for installation and operation instructions. Contractor shall pay any costs involved for this service.

3.2 OBSERVATION OF SITE CONDITIONS

A. All scaled dimensions are approximate. Contractor shall check and verify all size dimensions and receive approval from Landscape Architect prior to proceeding with work under this Section.

B. Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities which are caused by his operations or neglect. Check existing utilities drawings and field as-builts for existing utility locations.

C. Coordinate installation of irrigation materials including pipe, so there shall be NO interference with utilities or other construction or difficulty in planting trees, shrubs, and ground covers.

D. Contractor shall carefully check all grades to confirm that he may safely proceed before starting work on the irrigation system.

3.3 PREPARATION

A. Physical Layout:
   1. Prior to installation Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads.
   2. All layouts shall be reviewed by Landscape Architect prior to installation.
   3. Refer to plans for desired locations of irrigation control valve boxes.

B. Water Supply:
   1. The irrigation system shall be connected to water supply point(s) of connection as indicated on Drawings.
   2. Connections shall be made at the approximate location(s) as indicated on Drawings. Contractor is responsible for minor changes caused by actual site conditions.

C. Electrical Supply:
   1. Electrical connections for any and all automatic controllers shall be made to electrical point(s) of connection as indicated on Drawings.
   2. Connections shall be made at the approximate location(s) as indicated on Drawings. Contractor is responsible for minor changes caused by actual site conditions.

3.4 INSTALLATION

A. Trenching:
   1. Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow layout as indicated on Drawings and as noted.
   2. Provide for a minimum of 18 inches cover for all pressure supply lines of 2 1/2-inch nominal diameter or smaller.
   3. Provide for a minimum of 24 inches cover for all pressure supply lines of 3-inch nominal diameter or larger.
   4. Provide for a minimum of 12 inches for all non-pressure lines.
   5. Provide for a minimum cover of 18 inches for all control wiring.
   6. Provide for a minimum cover of 18 inches for all communication cable and flow sensor conduit.
   7. The maximum allowable trench depth shall be 42 inches for irrigation pressure main line piping and 24 inches for lateral line piping.

B. Backfilling:

1. The trenches shall not be backfilled until all required tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill will conform to adjacent grades without dips, sunken areas, humps or other surface irregularities.
2. For reclaimed water use, all certifications from water purveyor and Los Angeles County Health Department shall be obtained prior to backfilling.
3. A fine granular material backfill will be initially placed over, under and 4 inches around all lines. No foreign matter larger than a half- inch in size will be permitted in the initial backfill. If native soil is not suitable for backfill as outlined above, imported sand shall be used for the initial backfill.
4. Using manual or mechanical tamping devices, compact backfill in trenches to dry density equal to the adjacent undisturbed soil, and conform to adjacent grades without dips, sunken areas, humps, or other irregularities.
5. Do not, under any circumstances, use truck wheels for compacting soil.
6. If settlement occurs and necessitates adjustments in pipe, valves, irrgation heads, lawn, plantings, or other installed work, Contractor shall make all required adjustments without cost to Owner.

C. Trenching and Backfill Under Paving:

1. Trenches located under areas where paving, asphaltic concrete, or concrete will be installed, shall be backfilled with sand (a layer 6 inches below, over and around the pipe) and compacted in layers to 95% compaction, using manual or mechanical tamping devices. Trenches for piping shall be compacted to equal the compaction of the existing adjacent undisturbed soil and shall be left in a firm unyielding condition. All trenches shall be left flush with the adjoining grade. Contractor shall set in place, cap and pressure test all piping under paving prior to the paving work.
2. Generally, piping under existing walks is done by jacking, boring, or hydraulic driving, but where any cutting or breaking of sidewalks and/or concrete is necessary, it shall be done and replaced by Contractor as a part of the Contract cost. Permission to cut or break sidewalks and/or concrete shall be obtained from Landscape Architect.
   a. Hydraulic driving will not be permitted under concrete paving.
3. Provide for a minimum cover of 18 inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete paving or 36 inches from top of paving whichever is greater.

D. Trenching and Backfill in On-Structure Planters:

1. Dig trenches straight and support pipe continuously on bottom of trench with a minimum of 2 inches of planter mix. Lay pipe to an even grade. Trenching excavation shall follow layout as indicated on Drawings wherever possible.
2. Where possible, provide for a minimum cover over all piping and control wiring as noted in Article 3.4 of this Specification. Where it is not possible to install the specified minimum cover, Contractor shall install irrigation piping and control wiring to provide

for the maximum cover that the on-structure planter will allow. Protect fabric with 2-inch layer of planting soil mix. Provide 2 inches of planter mix as bedding material for pipe. Note depth of pipe on "As Built" Record Drawings.

3. The trenches shall not be backfilled until waterproofing is completed and approved and all required tests are performed. Trenches shall be carefully backfilled with excavated planter mix. Backfill shall be mechanically compacted in on-structure planting areas to a dry density equal to adjacent planter mix within on-structure planter. Backfill shall conform to adjacent grades without dips, sunken areas, humps, or other surface irregularities.

E. Plastic Pipe and Fittings:
   1. Install PVC plastic pipe, PVC plastic fittings and solvent welded joints in accordance with manufacturer's recommendations and installation guidelines. When requested, Contractor shall show evidence that the field personnel have been trained in the method of solvent welding PVC plastic pipe.
   2. Install irrigation heads on plastic pipe as indicated on Drawings.
   3. Prepare all welded joints with manufacturer's primer prior to applying solvent.
      a. Allow welded joints at least 15 minutes set-up/curing time before moving or handling.
      b. Partially center load pipe in trenches to prevent arching and shifting when water pressure is on
      c. Do not permit water in pipe until a period of at least 4 hours has elapsed for solvent weld setting and curing, unless recommended otherwise by solvent manufacturer.
   4. Do backfilling when pipe is cool.
      a. Pipe can be cooled by operating the system for a short time before backfill, or by backfilling in the early part of the morning before the heat of the day.
   5. Curing:
      a. When the temperature is above 80 degrees F., allow soluble weld joints at least 24 hours during the time before water is introduced under pressure.
      b. When temperature is below 80 degrees F., follow manufacturer's recommendations.

F. Assemblies:
   1. Routing of irrigation lines as indicated on Drawings is diagrammatic. Install lines (and various assemblies) in such a manner that conforms to Drawings.
   2. Do not install multiple assemblies in plastic lines. Provide each assembly with its own outlet.
   3. Install all assemblies specified herein in accordance with respective detail. In absence of Detail Drawings or Specifications pertaining to specific items required to complete work, perform such work in accordance with best standard practice with prior approval of Landscape Architect.
   4. PVC pipe and fittings shall be thoroughly cleaned of dirt, dust, and moisture before installation. Installation and solvent welding methods shall be as recommended by the pipe and fitting manufacturer.

5. On PVC to metal connections Contractor shall work the metal connections first. Teflon tape or approved equal, shall be used on all threaded PVC to PVC, and on all threaded PVC to metal joints. Light wrench pressure is all that is required. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be welded.

G. Conduit and Sleeves:
   1. Coordination: Sleeving will be existing only when installed under another contract. For all other installations, provide materials and coordinate conduit and sleeve installation with other trades as required to facilitate smooth construction sequence.
   2. Conduit: Furnish and install conduit where control wires pass under or through walls, footings, walks and paving. Conduits to be of adequate size to accommodate retrieval for repair of wiring and shall extend 12 inches beyond edges of walls and pavement.
   3. Sleeving: Install sleeves for all pipes passing through or under walks and paving as indicated on Drawings. Sleeving to be of adequate size to accommodate retrieval of wiring or piping for repair and shall extend 12 inches beyond edges of paving or other construction.

H. Line Clearance:
   1. All lines shall have a minimum clearance of 6 inches from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.

I. Automatic Controller Assembly:
   1. Install as indicated on Drawings and manufacturer's installation instructions. Electric control valves shall be connected to controller in numerical sequence as indicated on Drawings.

J. High Voltage Wiring for Automatic Controller:
   1. 120-volt and higher power connections to the irrigation components shall be provided by Contractor licensed to perform this work.
   2. All electrical work shall conform to the Electrical Division 16 of these Specifications local codes, ordinances, and union authorities having jurisdiction.

K. Grounding:
   1. Automatic controllers and other devices requiring grounding shall be grounded in accordance with manufacturer's installation guide.
   2. Refer to manufacturer’s recommendations for 2-Wire grounding requirements.

L. Electric Control Valves:
   1. Install each electric control valve in a separate valve box.
   2. Install where as indicated on Drawings. Where grouped together, allow at least 12 inches between adjacent valve boxes and 18 inches from edge of pavement.
   3. Each valve number shall be heat branded on valve box lid with 2-inch tall letters. Branding unit available from Hydroscape Products, Inc., (714) 639-1850 or approved equal.
   4. Brand valve box lid of associated equipment as follows:

a. Electric control valve box lid with “Controller Letter and Station Number”.
b. Quick coupling valve box lid with “Controller Letter” and the letters “QC”.
c. Isolation gate valve box lid with “Controller Letter” and the letters “GV”.
d. Air relief valve box lid with “Controller Letter” and the letters “AR”.
e. Wire splice box lid with “Controller Letter” and the letters “WS”.
f. Manual drain valve box lid with “Controller Letter” and the letters “MDV”.

M. Flushing of System:
1. After all new irrigation pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of irrigation heads, the control valves shall be opened and full head of water used to flush out the system.
2. Irrigation heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of Landscape Architect.

N. Irrigation Heads:
1. Install the irrigation heads as designated on Drawings. Irrigation heads to be installed in this work shall be equivalent in all respects to those itemized.
2. Spacing of heads shall not exceed the maximum as indicated on Drawings. In no case shall the spacing exceed the maximum recommended by the manufacturer.
3. Unless otherwise indicated on Drawings, all irrigation heads shall be set perpendicular to ground plane of the area to be irrigated.

O. Sub-Surface Drip Irrigation System:
1. Verify existing field dimensions of the area to be irrigated with Drawings for accuracy. Begin dripper tubing layout 2 inches to 3 inches away from both hard surfaces, i.e. concrete sidewalks, curbs, asphalt, and/or undefined edges, i.e. shovel-cut edges. Mark tubing intervals on the ground with flags, paint, or other markings that can be maintained throughout the installation.
2. Dripper tubing can be installed in one of the 3 following methods:
a. Over-Excavation: In small areas, where it technically feasible, over-excavate the entire area to a depth of 4 inches below finish grade. Plant all specimen trees and shrubs, 15-gallon size and larger, then place tubing at the row spacing interval as indicated on Drawings.
b. Pipe Pulling: In larger areas, where ground disruption is to be minimized, pneumatic tire, pipe pulling machinery shall be used. Potholes shall be used at the ends of each run for making connection to supply and exhaust headers of rigid PVC pipe or poly pipe.
c. Trenching: Hand or mechanically trench to the pipe depth as indicated on Drawings or in these Specifications and backfill flush with finish grade. Avoid mechanically trenching within the drip line of existing trees. Hand-trench around existing tree roots when roots of 2 inches and larger are encountered. Remove all rock 1-1/2-inch and larger when excavating and remove from site. Do not backfill trenches with rock that will come in direct contact with tubing or rigid PVC piping.

3. Install underground piping horizontally and as level as possible to a minimum depth of 3inches and maximum depth of 5 inches unless otherwise specified. Optimum pipe depth is 4inches.
4. As much as possible, supply and exhaust headers shall be installed perpendicular to contours.
5. As much as possible, dripper tubing shall be installed parallel with contours.
6. Dripper tubing can be installed with the water outlets facing upward or downward. Place dripper outlets in such a manner as to form a triangular pattern between parallel tubing laterals. In irregular areas, some water outlets may end up too close to fix improvements and may have to be capped off with a dripper plug ring.
7. Connect dripper tubing to barbed fittings by pushing on and over both barbs until the tubing has seated against another piece of tubing or has butted against another portion of the barbed fitting. For water pressures in excess of the 45 psi, use stainless steel clamps on all barbed fittings as noted in Paragraph 8 below.
8. When design operating pressure exceeds 45 psi, stainless steel pipe clamps shall be used. Slip clamps over tubing before slipping tubing over insert barbed fitting. Place clamp between the first and second ridge of the barbed fittings and crimp the “ear” of the clamp tightly. Crimp the “ear” twice to ensure proper seating.
9. Install a pressure regulator below grade, downstream, and in line with the remote control valve. Whenever possible, place the pressure regulator in the same valve box to allow for periodic inspection. Place the regulator with the arrow (molded into the side of the body) pointing in the direction of the flow of water. Provide straight piping on the outlet side of regulator for a dimension not less than 3 lengths of the overall body dimension.
10. Install the disc filter, horizontally level, below grade and before or after the remote control valve as indicated on Drawings. The position of the disc filter in the valve box shall be off-center to allow for removal of the disc element for periodic servicing. See Drawings for the size of the valve box.
11. Install the air/vacuum relief valve below grade and at the highest elevation within each zone. Depending on the site conditions and tubing layout, more than one air/vacuum relief valve into a 1/2 inch x 3/4 inch SCH 40 PVC reduction bushing and thread this assembly into a 180-degree two-way adapter tee with a 3/4 inch (MPT) outlet. Place the valve within a round valve box with a locking cover and a 1 cu. ft., 3/4 inch gravel sump as noted on the details. Additional blank Techline tubing may be necessary when placing Techline dripper tubing on mounds or berms with more than a 3-foot elevation difference. Blank Techline tubing shall be connected perpendicular to the dripper tubing with barbed tees from the lowest elevation of dripper tubing to the highest point of the mound berm where the air/vacuum relief valve is located. This air/vacuum relief lateral serves to collect and transport trapped air bubbles or relieve vacuum in lower elevation dripper tubing parallel to the dripper tubing located at the highest point in the system. Locate an air/vacuum relief lateral for each berm within the system.
12. Prior to backfilling and before connection of the line-flushing valves, flush the entire system to remove any dirt or sediment that may have entered the system during the installation.

13. Install the line-flushing valve horizontally level and below grade at the hydraulic termination point(s) in each system. Locate in a valve box with the dome-shape of the valve facing upward. Include a minimum of 1 cu. ft. of 3/4-inch gravel in the bottom of the valve box per Detail.
14. Prior to backfilling, open the remote control valve and operate each circuit to check for leakage around both barbed and threaded PVC fittings. Make necessary corrections to stop leaks.
15. Re-test those systems where leaks were corrected before commencing backfilling operations.

3.5 TEMPORARY REPAIRS

A. Owner reserves the right to make temporary repairs as necessary to keep the irrigation system equipment in operating condition. The exercise of this right by Owner shall not relieve Contractor of his responsibilities under the terms of the guarantee as herein specified.

3.6 FIELD QUALITY CONTROL

A. Adjustment of the System:
   1. Contractor shall flush and adjust all irrigation heads for optimum performance and to prevent overspray upon walks, roadways, and buildings as much as possible.
   2. If it is determined that adjustment to the irrigation equipment will provide proper and more adequate coverage, Contractor shall make such adjustments prior to planting. Adjustments may also include changes in nozzle sizes and degrees of arc as required.
   3. Lowering raised irrigation heads by Contractor shall be accomplished within 10 working days after notification by Landscape Architect.
   4. All irrigation heads shall be set perpendicular to finished grades unless otherwise indicated on Drawings.

B. Testing of the Irrigation System:
   1. Contractor shall request the presence of Landscape Architect in writing at least 48 hours in advance of testing.
   2. Test all pressure lines under hydrostatic pressure of 150 pounds per square inch and prove watertight.
      a. Testing of pressure main lines shall occur prior to installation of the electric control valves.
   3. All piping under paved areas shall be tested under hydrostatic pressure of 150 pounds per square inch and proven watertight prior to paving.
   4. Sustain pressure in lines for not less than 2 hours. If leaks develop, replace joints and repeat test until entire system is proven watertight.
   5. All hydrostatic tests shall be made only in the presence of Landscape Architect. No pipe shall be backfilled until it has been observed, tested, and approved in writing.
   6. Furnish necessary force pump and all other test equipment.

7. When the irrigation system is completed, perform a coverage test in the presence of Landscape Architect to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from Drawings, or where the system has been willfully installed as indicated on Drawings when it is obviously inadequate, without bringing this to the attention of Landscape Architect. This test shall be accomplished before any ground cover is planted.
8. Upon completion of each phase of work, the entire system shall be tested and adjusted to meet site requirements.
9. Coordinate with Calsense for final review of equipment and certification. Coordinate all data connections with the Expo Center for water management, if required.
10. Coordinate with booster pump manufacturer for final pump start up and certification. All warranty information shall be registered.

3.7 MAINTENANCE

A. The entire irrigation system shall be under full automatic operation for a period of 7 working days prior to any planting.

B. Landscape Architect reserves the right to waive or shorten the operation period.

3.8 CLEANUP

A. Cleanup shall be made as each portion of work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be broomed or washed down, and any damage occurring to the work of others shall be repaired to original conditions.

3.9 FINAL SITE OBSERVATION PRIOR TO ACCEPTANCE

A. Contractor shall operate each system in its entirety for Landscape Architect at the time of Final Observation. Any items deemed unacceptable by Landscape Architect shall be reworked to the complete satisfaction of Landscape Architect.

B. Contractor shall show evidence to Landscape Architect that Owner has received all accessories, Charts, Record Drawings, and equipment as required before Final Site Observation can occur.

3.10 SITE OBSERVATION SCHEDULE

A. Contractor shall be responsible for notifying Landscape Architect in advance for the following observation meetings, according to the time indicated:
   1. Pre-Job Conference - 7 working days
   2. Pressure Supply Line Installation and Testing - 48 hours
   3. Control wire installation and communication/flow sensor cable installation - 48 hours
   4. Lateral Line and Sprinkler Installation - 48 hours

5. Cross contamination testing – 48 hours.
6. Sub-Surface dripline Installation - 48 hours.
7. Coverage Test - 48 hours
8. Final Site Observation - 7 working days

B. When site observations have been conducted by a party other than Landscape Architect, show evidence in writing of when and by whom these observations were made.

C. Prior to reviewing the irrigation system with Landscape Architect, Contractor shall pre-walk the irrigation system with its own crew to ensure compliance with Drawings and Specifications. Contractor shall observe those items shown on the Construction Observation Check List below and initial and date that all items observed are in accordance with Drawings and Specifications. This list shall be presented to Landscape Architect prior to the Final Irrigation Walk-Through with Landscape Architect.

D. No site observations will commence without “As-Built” Record Drawings or the Construction Observation Check List. In the event that Contractor calls for a site visit without “As-Built” Record Drawings or the Construction Observation Check List, without completing previously noted corrections or without preparing the system for said visit, Contractor shall be responsible for reimbursing Landscape Architect at his current hourly billing rate, portal-to-portal (plus transportation costs), for the inconvenience. No further site observations will be scheduled until this charge has been paid and received

CONSTRUCTION OBSERVATION CHECK LIST

The following checklist and acceptance form shall be re-typed on Contractor's letterhead. The form shall be completed by Contractor and shall contain the all of the information shown on this sample checklist form:

PROJECT NAME: _____

PROJECT LOCATION: _____

DESCRIPTION:	Completed by Contractor	Date	Approved by Landscape Architect	Date
Irrigation Heads				
Heads plumb and straight				
Spacing per design intent				
Correct nozzles used				
Pressure set appropriately				
PCS Screens installed				
Non Potable Caps (when required)				
Heads at correct height				
Back-up heads properly located				
Turn down screws used only for minor adjustments only				
Nozzles are clean and unobstructed				
Pop-up heads retracting properly				
Heads adjacent to building/paving located correctly				
Head to head coverage ok				
Minimal overspray				
Swing joints installed				
No leaks observed				
Systems on slopes separated correctly				
Direction of spray appropriate				
No low head drainage				
Rotor are rotating				
Install van nozzles where necessary				
Proper arc patterns installed				

DESCRIPTION:	Completed by Contractor	Date	Approved by Landscape Architect	Date
Valves All Sizes And Types				
Correct size of boxes				
Correct color of boxes				
Heat branding complete				
Height of valves in boxes				
Gravel in boxes (2cu. ft.) installed				
Brick supports in boxes installed				
Valve I.D. tags installed				
Pressure setting on valve set properly				
PVC sleeve in box at gate valve				
Bolt downs on boxes provided				
No leaks observed				
Correct clearance from valve to gravel provided				
Brass hand wheel installed				
2-inch operating nuts installed				
Proper wire connectors installed				
Automatic Controllers				
Location set per plan				
Secured to wall properly				
Door opens and closes properly				
Copper ground rod installed				
Run shut-off installed				
Connections and wires verified				
Certification letter provided				
Power provided and controller operational				
Proper gauge and color of control and common wires.				
Sub-Surface Drip Installation				
Filter assembly is installed				
Pressure Regulator is installed				
Air/vacuum relief valve installed				
Flushing valve installed				
Additional Items				

Pressure test documentation complete				
Coverage test complete				

END OF SECTION

SECTION 32 91 00 - PLANTING SOIL

PART 1 – GENERAL

1.1 SUMMARY

A. The scope of work includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soil and /or the modification of existing site soil for use as Planting Soil, complete as shown on the drawings and as specified herein.

B. The scope of work in this section includes, but is not limited to, the following:

1. Locate, purchase, deliver and install Imported Planting Soil and soil amendments.
2. Harvest and stockpile existing site soils suitable for Planting Soil.
3. Modify existing stockpiled site soil.
   a. Modify existing site soil in place for use as Planting Soil.
   b. Install existing or modified existing soil for use as Planting Soil.
4. Locate, purchase, deliver and install subsurface Drain Lines.
5. Fine grade Planting Soil.
6. Install Compost into Planting Soil.
7. Clean up and disposal of all excess and surplus material.

1.2 CONTRACT DOCUMENTS

A. Shall consist of specifications, general conditions, and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

A. Related Documents:

1. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.
2. Related Specification Section
   a. Section 32 9300 - Planting
   b. Section 32 8400 - Irrigation
   c. Section 01 5639 -Tree and Plant Protection

B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the Specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

1. ASTM: American Society of Testing Materials cited section numbers.
2. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.
3. US Composting Council *www.compostingcouncil.org and* http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf.
4. *Methods of Soil Analysis*, as published by the Soil Science Society of America (http://www.soils.org/).
5. Up by Roots: healthy soils and trees in the built environment. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

1.4 VERIFICATION

A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities and shall immediately inform the Landscape Architect of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Landscape Architect.

1.5 PERMITS AND REGULATIONS

A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Landscape Architect in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

C. In case of conflict among any referenced standards or codes or among any referenced standards and codes and the specifications, the more restrictive standard shall apply, or Landscape Architect shall determine which shall govern.

D. Comply with the requirements of the California code of regulation title 23 waters, division 2 department of water resources chapter 2.7 model water efficient landscape ordinance, 492.5 soil management report.

1. Where requirements of specification section Planting Soil are more stringent than the California code, the more stringent requirements shall prevail.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CHANGES IN WORK

A. The Landscape Architect may order changes in the work, and the contract sum adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.

B. All changes in the work, notifications and contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Landscape Architect, at the soonest possible time that can be coordinated with other work and seasonal weather demands but not more than 180 (one hundred and eighty) days after notification**.**

1.9 DEFINITIONS

A. Acceptable drainage: Drainage rate is sufficient for the plants to be grown. Not too fast and not too slow. Typical rates for installed Planting Soil are between 1 - 5 inches per hour. Turf soils are often higher, but drainage rates above 2 - 3 inches per hour will dry out very fast. In natural undisturbed soil a much lower drainage rate, as low as 1/8th inch per hour can still support good plant growth. Wetland plants can grow on top of perched water layers or even within seasonal perched water layers, but could become unstable in high wind events.

B. Amendment: material added to Topsoil to produce Planting Soil Mix. Amendments are classified as general soil amendments, fertilizers, biological, and pH amendments.

C. Biological Amendment: Amendments such as Mycorrhizal additives, compost tea or other products intended to change the soil biology.

D. Compacted soil: soil where the density of the soil is greater that the threshold for root limiting, and further defined in this specification.

E. Compost: well decomposed stable organic material as defined by the US Composting Council and further defined in this specification.

F. Drainage: The rate at which soil water moves through the soil transitioning the soil from saturated condition to field capacity. Most often expressed as saturated hydraulic conductivity (Ksat; units are inches per hour).

G. End of Warranty Acceptance: The date when the Landscape Architect accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation (if applicable) work run concurrent with each other, and further defined in this specification.

H. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting, and further defined in this specification.

I. Fertilizer: amendment used for the purpose of adjusting soil nutrient composition and balance.

J. Fine grading: The final grading of the soil to achieve exact contours and positive drainage,

often accomplished by hand rakes or drag rakes other suitable devices, and further defined in this specification, and further defined in this specification.

K. Finished grade: surface or elevation of Planting Soil after final grading and 12 months of settlement of the soil, and further defined in this specification.

L. Graded soil: Soil where the A horizon has been stripped and relocated or re-spread; cuts and fills deeper than 12 inches, and further defined in this specification.

M. Installed soil: Planting soil and existing site soil that is spread and or graded to form a planting soil, and further defined in this specification.

N. Minor disturbance: Minor grading as part of agricultural work that only adjusts the A horizon soil, minor surface compaction in the top 6 inches of the soil, applications of fertilizers, installation of utility pipes smaller than 18 inches in diameter thru the soil zone.

O. Landscape Architect: The person or entity, appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Landscape Architect may appoint other persons to review and approve any aspects of the work.

P. Ped: a clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.

Q. Planting Soil: Topsoil, or Planting Soil Mixes which are imported or existing at the site, or made from components that exist at the site, or are imported to the site; and further defined in this specification.

R. Poor drainage: Soil drainage that is slower than that to which the plants can adapt. This is a wide range of metrics, but generally if the soil is turning grey in color it is reasonable preferable to either to plant moisture adaptive plants at smaller sizes that are young in age with shallow root balls or look at options to improve the drainage

S. Punch List: List of work within the Contract, generated by Architect that needs to be completed, repaired, replaced, or rectified by Contractor

T. Scarify: Loosening and roughening the surface of soil and sub soil prior to adding additional soil on top, and further defined in this specification.

U. Soil Fracturing: Deep loosening the soil to the depths specified by using a back hoe, and further defined in this specification.

V. Soil Horizons: as defined in the USDA National Soil Survey Handbook

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242.

W. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified, and further defined in this specification.

X. Soil Tilling: Loosening the surface of the soil to the depths specified with a **rotary tine tilling machine, roto tiller, (or spade tiller)**, and further defined in this specification**.**

Y. Soil trenching: Cutting narrow trenches thru the soil at the depths and spacing specified to loosen the soil profile, and further defined in this specification.

Z. Subgrade: surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing Planting Soil.

AA. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation (if applicable) where the Landscape Architect accepts that all work in these sections is complete, and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project, and further defined in this specification.

BB. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.

CC. Undisturbed soil: Soils with the original A horizon intact that have not been graded or compacted. Soils that have been farmed, subjected to fire or logged but not graded, and natural forested land will be considered as undisturbed.

1.10 SUBMITTALS

A. See the contract General Conditions for policy and procedures related to submittals.

B. Submit all product submittals eight weeks prior to the start of the soil work.

C. Product data and certificates: For each type of manufactured product, submit data and certificates that the product meets the specification requirements, signed by the product manufacturer, and complying with the following:

1. Submit manufacturers or supplier's product data and literature certified analysis for standard products and bulk materials, complying with testing requirements and referenced standards and specific requested testing.

a. For each Compost product submit the following analysis by a recognized laboratory:
1.) pH
2.) Salt concentration (electrical conductivity)
3.) Moisture content %, wet weight basis
4.) Particle size % passing a selected mesh size, dry weight basis
5.) Stability carbon dioxide evolution rate mg CO2-C per g OM per day
6.) Solvita maturity test
7.) Physical contaminants (inerts) %, dry weight basis
8.) US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels Chemical Contaminants mg/kg (ppm)

b. For Coarse Sand product submit the following analysis by a recognized laboratory:
1.) pH
2.) Particle size distribution (percent passing the following sieve sizes):
3/8 inch (9.5 mm)
No 4 (4.75 mm)
No 8 (2.36 mm)
No 16(1.18 mm)
No 30 (.60 mm)
No 50 (.30 mm)
No 100 (.15 mm)
No 200 (.075 mm)

D. Samples: Submit samples of each product and material, where required by Part 2 of the specification, to the Landscape Architect for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only.

1. Submit samples a minimum of 8 weeks prior to the anticipated date of the start of soil installation.
2. Samples of all Topsoil, Coarse Sand, Compost and Planting Soil shall be submitted at the same time as the particle size and physical analysis of that material.

E. Soil testing for Imported and Existing Topsoil, existing site soil to be modified as Planting Soil and Planting Soil Mixes.

1. Topsoil, existing site soil and Planting Soil Mix testing: Submit soil test analysis report for each sample of Topsoil, existing site soil and Planting Soil from an approved soil-testing laboratory and where indicated in Part 2 of the specification as follows:
   a. Submit Topsoil, Planting Soil, Compost, and Coarse Sand for testing at least 8 weeks before scheduled installation of Planting Soil Mixes. Submit Planting Soil Mix test no more than 2 weeks after the approval of the Topsoil, Compost and Coarse Sand. Do not submit to the testing laboratory, Planting Soil Mixes, for testing until all Topsoil, Compost and Coarse Sand have been approved.
   b. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Landscape Architect.
   c. All soil testing will be at the expense of the Contractor.
   d. Submit a copy of the Planting Plan and Plant Legend to the laboratory with the samples. Soil test of fertility, agricultural suitability, and appraisal by the following (or approved equal, see Quality Assurance section):
      1.) Wallace Laboratories (310) 615-0116, info@wlabs.com, wlabs.com.
2. Submit all testing required by California Code of regulation Title 23 waters, Division 2 Department of Water resources Chapter 2.7 Model Water Efficient Landscape Ordinance, 492.5 Soil Management Report.
3. Provide a particle size analysis (% dry weight) and USDA soil texture analysis. Soil testing of Planting Soil Mixes shall also include USDA gradation (percentage) of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay.
4. Provide the following other soil properties:
   a. pH and buffer pH.
   b. Percent organic content by oven dried weight.
   c. Nutrient levels by parts per million including: boron, copper, molybdenum, sodium, sulfur, phosphorus, potassium, magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
   d. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
   e. Cation Exchange Capacity (CEC).
   f. Bulk Density
      1.) Dry Weight Basis (pounds per cubic foot)
      2.) At max. water holding capacity (pounds per cubic foot)

1.11 OBSERVATION OF THE WORK

A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.

1. The Landscape Architect may utilize the Contractor’s penetrometer and moisture meter at any time to check soil compaction and moisture.

B. The Landscape Architect shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visit to the site if necessary. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1. COMPLETION OF FINE GRADING AND SURFACE SOIL MODIFICATIONS REVIEW: Upon completion of all surface soil modifications and fine grading but prior to the installation of shrubs, ground covers, or lawns.

1.12 QUALITY ASSURANCE

A. Installer Qualifications: The installer shall be a firm having at least 5 years of experience of a scope similar to that required for the work, including the preparation, mixing and installation of soil mixes to support planting. The installer of the work in Section: Planting, shall be the same firm installing the work in this section.

1. The bidders list for work under this section shall be approved by the Landscape Architect.

2. Installer Field Supervision: When any Planting Soil work is in progress, installer shall maintain, on site, an experienced full-time supervisor who can communicate in English with the Landscape Architect.

3. Installer’s field supervisor shall have a minimum of five year’s experience as a field supervisor installing soil, shall be trained and proficient in the use of field surveying equipment to establish grades and can communicate in English with the Landscape Architect.

4. The installer’s crew shall be experienced in the installation of Planting Soil, plantings, and irrigation (where applicable) and interpretation of planting plans, soil installation plans, and irrigation plans (where applicable).

5. Submit references of past projects and employee training certifications that support that the Contractors meet all of the above installer qualifications and applicable licensures.

B. Soil testing laboratory qualifications: an independent laboratory, with the experience and capability to conduct the testing indicated and that specializes in USDA agricultural soil testing, Planting Soil Mixes, and the types of tests to be performed. Geotechnical engineering testing labs shall not be used.

C. All delivered and installed Planting Soil shall conform to the approved submittals sample color, texture and approved test analysis.

1. The Landscape Architect may request samples of the delivered or installed soil be tested for analysis to confirm the Planting Soil conforms to the approved material.
2. All testing shall be performed by the same soil lab that performed the original Planting Soil testing.
3. Testing results shall be within 10% plus or minus of the values measured in the approved Planting Soil Mixes.
4. Any Planting Soil that fails to meet the above criteria, if requested by the Landscape Architect, shall be removed and new soil installed.

D. Soil compaction testing: following installation or modification of soil, test soil compaction with a penetrometer.

1. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
   a. Penetrometer shall be AgraTronix Soil Compaction Meter distributed by Ben Meadows, www.benmeadows.com or approved equal.
   b. Moisture meter shall be “general digital soil moisture meter” distributed by Ben Meadows, www.benmeadows.com or approved equal.
2. Prior to testing the soil with the penetrometer check the soil moisture and penetrometer readings in the mockup soils. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.
3. The penetrometer readings shall be within 20% plus or minus of the readings in the approved mockup when at similar moisture levels.

1.13 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and subsurface conditions, and to notify the Landscape Architect, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.

1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Landscape Architect in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Landscape Architect of such conditions, they shall remain responsible for plant material under the warrantee clause of the specifications.
2. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.

1.14 SOIL COMPACTION – GENERAL REQUIREMENTS

A. Except where more stringent requirements are defined in this specification. The following parameters shall define the general description of the threshold points of soil compaction in existing, modified or installed soil and subsoil.

B. The following are threshold levels of compaction as determined by each method.

1. Acceptable Compaction: Good rooting anticipated, but increasing settlement expected as compaction is reduced and/or in soil with a high organic matter content.
   a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
   b. Standard Proctor Method – 75-85%; soil below 75% is unstable and will settle excessively.
   c. Penetration Resistance Method – about 75-250 psi, below 75 psi soil becomes increasingly unstable and will settle excessively.
2. Root limiting Compaction: Root growth is limited with fewer, shorter and slower growing roots.
   a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
   b. Standard Proctor Method – above approximately 85%.
   c. Penetration Resistance Method – about 300 psi.
3. Excessive Compaction: Roots not likely to grow but can penetrate soil when soil is above field capacity.
   a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
   b. Standard Proctor Method – Above 90%.
   c. Penetration Resistance Method – Approximately above 400 psi

1.15 DELIVERY, STORAGE, AND HANDLING

A. Weather: Do not mix, deliver, place or grade soils when frozen or with moisture above field capacity.

B. Protect soil and soil stockpiles, including the stockpiles at the soil blender's yard, from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Cover stockpiles with plastic sheeting or fabric at the end of each workday.

C. All manufactured packaged products and material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the year in which the products are to be used.

D. Deliver all chemical amendments in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in a weather protected enclosure.

E. Bulk material: Coordinate delivery and storage with Landscape Architect and confine materials to neat piles in areas acceptable to Landscape Architect.

1.16 EXCAVATING AND GRADING AROUND UTILITIES

A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavation as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.

C. Notification of DigAlert, #811 is required for all planting areas. The Contractor is responsible

for knowing the location and avoiding utilities that are not covered by DigAlert.

PART 2 – PRODUCTS

2.1 IMPORTED TOPSOIL

A. Imported Topsoil definition: Fertile, friable soil containing less than 5% total volume of the combination of subsoil, refuse, roots larger than 1 inch diameter, heavy, sticky or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substances deleterious to plant growth. It shall also be free from wire, plaster, construction debris, or similar objects that would be a hindrance to planting or maintenance. The percent (%) of the above objects shall be controlled by source selection not by screening the soil. Topsoil shall be suitable for the germination of seeds and the support of vegetative growth. Imported Topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds. It shall not be infested with nematodes or other undesirable disease-causing organisms such as insects and plant pathogens. Imported Topsoil shall meet the following physical and chemical criteria:

1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 50%.
   a. Particle Size and Composition
      1.) Coarse Sand (0.5 to 2.0mm), up to 15%
      2.) Silt plus clay (<0.05mm), 15% to 50%
      3.) Other Classes
         a.) Gravel (2 to 13mm), up to 15%
         b.) Rock (1/2-inch to 1 inch), up to 5%
         c.) Rock (greater than 1 inch), not allowed, 0%
2. pH value shall be between 5.5 and 7.8 without high lime content.
3. Percent organic matter (OM): 2.0-5.0%, by dry weight.
4. Soluble salt level: Less than 2 mmho/cm.
5. Soil chemistry suitable for growing the plants specified.
   a. Salinity: Saturation Extract Conductivity (ECe) - less than 3.0 sD/m @ 25° C
   b. Sodium: Sodium Absorption Ratio (SAR) - less than 6.0
   c. Boron: Saturation Extract Concentration - Less than 1.0 ppm
   d. Soil shall contain sufficient quantities of available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant grown. In the event of nutrient inadequacies, provisions shall be made to add required material prior to planting.

B. Imported Topsoil shall be a harvested soil from fields or development sites. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where Coarse Sand, composted organic material or chemical additives has been added to the soil to meet the requirements of this specification section shall not be acceptable. Retained soil peds shall be the same color on the inside as is visible on the outside.

C. Imported Topsoil for Planting Soil shall NOT have been screened and shall retain soil peds or clods larger than 2 inches in diameter throughout the stockpile after harvesting.

D. Stockpiled Existing Topsoil at the site meeting the above criteria may be acceptable.

E. Provide a two-gallon sample from each Imported Topsoil source with required soil testing results. The sample shall be a mixture of the random samples taken around the source stockpile or field. The soil sample shall be delivered with soil peds intact that represent the size and quantity of expected peds in the final delivered soil.

2.2 COMPOST

A. Compost: Blended and ground leaf, wood and other plant-based material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plant or manure-based material designed to produce Compost high in fungal material.

1. Compost shall be commercially prepared Compost and meet US Compost Council STA/TMECC criteria or as modified in this section for “Compost as a Landscape Backfill Mix Component”.

   http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf

2. High Value Compost shall comply with the following parameters:
   a. Composted aerobic humus compost without presence of decomposition products. The organic matter content shall be at least 50% on a dry weight basis. Humus material shall have an acid-soluble ash content of no less than 6% and no more than 20%.
   b. The pH of the material shall be between 6 and 7.5.
   c. The salt content shall be less than 6 millimho/cm @ 25° C. (ECe less than 6) in a saturated paste extract.
   d. Boron content of the saturated extract shall be less than 1.0 part per million.
   e. Silicon content (acid-insoluble ash) shall be less than 50%.
   f. Calcium carbonate shall not be present if to be applied on alkaline soils.
   g. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
   h. Composted wood products are conditionally acceptable [stable humus must be present]. Wood based products are not acceptable which are based on red wood or cedar.
   i. Sludge-based materials are not acceptable.
   j. Carbon:nitrogen ratio is between 8.0 and 20:1.
   k. SAR (sodium adsorption ratio) less than 5.
   l. Seed germination - over 80% germination in saturation extract diluted 1 to 3 in water compared to seeds germinated in deionized water.
   m. Germination vigor - equal to or better than seed length for seeds germinated in deionized water.
   n. Maturity and stability – Solvita 5 or higher.
   o. Molar ratio of ammoniacal nitrogen to nitrate nitrogen less than 2.
   p. The compost shall be aerobic without malodorous presence of decomposition products.

q. The maximum particle size shall be 0.5 inch, 80% or more shall pass a No. 4 screen.

3. Maximum total permissible pollutant concentrations in amendment in parts per million on a dry weight basis:
   a. arsenic 12
   b. cadmium 15
   c. chromium 100
   d. cobalt 50
   e. copper 100
   f. lead 100
   g. mercury 10
   h. molybdenum 20
   i. nickel 100
   j. selenium 20
   k. silver 10
   l. vanadium 50
   m. zinc 200
4. Regular Compost shall comply with the following parameters:
   a. Humus material shall have an acid-soluble ash content of no less than 5% and no more than 20%. Organic matter shall be at least 50% on a dry weight basis.
   b. The pH of the material shall be between 6 and 7.8.
   c. The salt content shall be less than 10 millimho/cm @ 25° C. in a saturated paste extract.
   d. Boron content of the saturated extract shall be less than 1.0 parts per million.
   e. Silicon content (acid-insoluble ash) shall be less than 50%.
   f. Organic matter shall be at least 50% on a dry weight basis.
   g. Calcium carbonate shall not be present if to be applied on alkaline soils.
   h. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
   i. Composted wood products are conditionally acceptable [stable humus must be present]. Wood based products are not acceptable which are based on red wood or cedar.
   j. Sludge-based materials are not acceptable.
   k. Carbon:nitrogen ratio is less than 25:1.
   l. The compost shall be aerobic without malodorous presence of decomposition products.
   m. The maximum particle size shall be 0.5 inch, 80% or more shall pass a No. 4 screen for soil amending. The maximum particle size shall be 0.25 inch for hydroseeding.
5. Maximum total permissible pollutant concentrations in amendment in parts per million on a dry weight basis:
   a. arsenic 12
   b. cadmium 15
   c. chromium 200
   d. cobalt 50
   e. copper 150

f. lead 200
g. mercury 10
h. molybdenum 20
i. nickel 100
j. selenium 30
k. silver5
l. vanadium 50
m. zinc 250
n. Higher amounts of salinity or boron may be present if the soils are to be preleached to reduce the excess or if the plant species will tolerate the salinity and/or boron.

6. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.3 COARSE SAND

A. Clean, washed, sand, free of toxic materials

1. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.

2. Coarse Sands shall be clean, sharp, natural Coarse Sands free of limestone, shale and slate particles. Manufactured Coarse Sand shall not be permitted.

3. pH shall be lower than 7.0.

4. Provide Coarse Sand with the following particle size distribution:

Sieve	Percent passing
3/8 inch (9.5 mm)	100
No 4 (4.75 mm)	95-100
No 8 (2.36 mm)	80-100
No 16 (1.18 mm)	50-85
No 30 (.60 mm)	25-60
No 50 (.30 mm)	10-30
No 100 (.15 mm)	2-10
No 200 (0.75 mm	2-5

B. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

C. Medium Coarse Sand shall be used as a backfill material for Palm Trees. Refer to the Section 32 93 00 – Planting.

2.4 FERTILIZER, BIOLOGICAL AND OTHER AMENDMENTS

A. Contractor shall provide amendments recommended by Soils Report at no additional cost to Owner, including recommendations for the quality of organic amendment.

B. Mycorrhizal fungi shall be added in all planting areas, regardless of Soils Report.

1. Mycorrhizal inoculum consists of a combination of :
a. Blend of eight top types of Endospores: Glomus aggregatum, G. clarum, G. deserticola, G. intraradices, G. monosporus, G. mosseae, Gigaspora margarita, and

Paraglomus brasilianum,
b. Blend of seven top types of Ecto fungi spores:Lacarria laccata, Pisolithus tinctorius, Rhizopogon amylpogon, R. fulvigleba, R. rubescens, R. villosuli, and Scleroderma spp.
c. The guaranteed Endo spore count shall be a minimum 50 spores/cc,
d. The Ecto spore count shall be a minimum 50,000 spores/cc

2. Manufacturers:
a. BioOrganics Mycorrhizae Inoculants, (888) 332-7676
b. Mycorrhizal Applications, Inc, (866) 476-7800
c. Fox Farm, (800) 436-9327
d. Or approved equal.

2.5 LIME

A. ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.

2. Provide lime in form of dolomitic limestone.

B. Provide manufacturer's literature and material certification that the product meets the requirements.

2.6 EXISTING SOIL (Site Soil Acceptable for planting with minimum modifications)

A. General definition of existing soil: Surface soil in the areas designated on the soils plan as existing soil, that is not altered, compacted to root limiting density, graded or contaminated before or during the construction process and considered acceptable for planting and long-term health of the plants specified either as it exists or with only minor modification.

1. The Landscape Architect shall verify that the soil in the designated areas is suitable at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for use as Planting Soil to the point where the soil is no longer suitable to support the plants specified, the Landscape Architect may require modification of the damaged soil up to and including removal and replacement with soil of equal quality to the soil that existed prior to construction. Examples of damage include further compaction, contamination, grading, creation of hard pan or drainage problems, and loss of the O, and or A horizon.
a. Do not begin work on additional modifications until changes to the contract price are approved by Landscape Architect.

B. Protect existing soil from compaction, contamination, and degradation during the construction process.

C. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not increase compaction of soil to root limiting levels.

D. Modifications:

1. When results of soil tests recommend chemical adjustments, till surface soil to six inches or greater after chemical adjustments have been are applied.
2. Remove existing turf thatch, ground cover plants and weeds.
3. Provide pre-emergent weed control if indicated.
4. Make chemical adjustment as recommended by the soil test.

2.7 MODIFIED EXISTING SOIL (SITE SOIL SUITABLE FOR PLANTING WITH INDICATED MODIFICATION)

A. General definition: Surface soil in the areas designated on the soils plan or by the Landscape Architect as Modified Existing Soil has been altered and or graded before or during the construction process but is still considered acceptable for planting and long-term health of the plants specified with the proposed modifications. Modifications respond to the soil problems expected or encountered. The Landscape Architect shall verify that the soil in the designated areas is suitable for modification at the beginning of planting bed preparation work in that area.

1. The Landscape Architect shall verify that the soil in the designated areas is suitable for the specified modification at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for modification to the point where the soil is no longer suitable to support the plants specified with the specified modification, the Landscape Architect may require further modification of the damaged soil up to an including removal and replacement with soil of equal quality to the soil that would have resulted from the modification. Damage may include further compaction, contamination, grading, creation of hard pan or drainage problem, and loss of the O, and or A horizon.
2. General requirements for all soil modifications:
   a. Take soil samples, test for chemical properties, and make appropriate adjustments.
   b. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not add to the compaction in the soil.
   c. All soil grading, tilling and loosening must be completed at times when the soil moisture is below field capacity. Allow soil to drain for at least two days after any rain event more than 1 inch in 24 hours, or long enough so that the soil does not make the hand muddy when squeezed.
   d. Provide pre-emergent weed control after the soil work is complete and plants planted but prior to adding mulch to the surface, if indicated by weed type and degree of threat.

B. Modified existing soil – soil removed, stockpiled, and spread

1. Existing soil that is suitable for reuse as Planting Soil but is in the wrong place of elevation or cannot be adequately protected during construction. Soil is to be harvested, stockpiled and re-spread with or without further modifications as indicated.
2. Modifications:
   a. Excavate existing soil from the areas and to depths designated on the drawings.

Stockpile in zones noted on the drawings or in areas proposed by the Contractor.
1.) Prepare a soil stockpile plan for approval.

b. Excavate soil using equipment and methods to preserve the clumps and peds in the soil. Generally, this means using the largest piece of equipment that is practical for the project size and scope.
c. Protect stockpiles from erosion by compacting or tracking the soil surface, covering with breathable fabric or planting with annual grasses as appropriate for the season, location, and length of expected time of storage.
d. Re-spread soil as required in Part 3 of this specification.

C. Modified existing soil – compacted surface soil (Tilling Option).

1. Description of condition to be modified: Surface soil compaction to a maximum of 6 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

2. Modifications:

a. Till top 6 inches or deeper of the soil surface, with a *roto tiller, spade tiller,* ripper or agricultural plow. Spread 2 - 3 inches of Compost on the surface of the tilled soil and make any chemical adjustment as recommended by the soil test.
b. Till or disk the Compost into the loosened soil. Smooth out grades with a drag rake or drag slip.

D. Modified existing soil – compacted surface soil (Radial Trenching Option)

1. Description of condition to be modified: Surface soil compaction to a maximum of 24 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile below 24 inches intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

2. Modifications:
a. Using a trenching machine, dig trenches to the extent and depth shown on the plans and details.
b. Backfill the trench with the soil removed from the trench. Add additional site soil if needed to fill the trench to be flush to the existing grade after the soil settlement.

E. Modified existing soil – compacted subsoil

1. Description of condition to be modified: Deep soil compaction the result of previous grading, filling and dynamic or static compaction forces. Original A horizon likely removed or buried. The soil organic matter, pH and chemistry in the A horizon is likely not suitable for the proposed plants and should be modified as required.

2. Soil Ripping:
a. Step one: After grading and removing all plants and debris from the surface, using a tracked dozer or similar large grading equipment, loosen the soil by dragging a ripping shank or chisel thru the soil to depths of 24 inches with ripping shanks

spaced 18 inches or less apart in two directions. The number of shanks per pull is dependent on the degree of soil compaction and the size of the dozer.

b. Step 2: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.

3. Soil Fracturing:
   a. Step one: After grading and removing all plants and debris from the surface, spread 2 – 3 inches of Compost over the surface of the soil. Loosen the soil to depth of 18 - 24 inches, using a backhoe to dig into the soil through the Compost. Lift and then drop the loosened soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats the process until the entire area indicated has been loosened.
   b. Step 2: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
4. Trenching:
   a. Step one: After grading and removing all plants and debris from the surface using a chain trenching machine, dig 24 inch deep trenches, 24 inches apart across the entire area. Maintain an 18-inch standoff from the edges of all curbs, paving and structures. Backfill the trenches with Compost.
   b. Step 2: Spread 3-4 inches of Compost over the trenches area and till into the top 6 inches of the soil surface. Compost tilling treatment shall extend to the edges of curbs, paving and structures.
5. Following soil ripping or fracturing the average penetration resistance should be less than 250 psi to the depth of the ripping or fracturing.
6. Do not start planting into ripped or fractured soil until soil has been settled or leave grades sufficiently high to anticipate settlement of 10 – 15% of ripped soil depth.

F. Modified existing soil – low organic matter

1. Description of condition to be modified: Low soil organic matter and/or missing A horizon but soil is not compacted except for some minor surface compaction. The soil organic matter, pH and/or chemistry are likely not suitable for the proposed plants and should be modified as required.
2. Modifications:
   a. Spread 3 - 4 inches of Compost over the surface of the soil and make chemical adjustment as recommended by the soil test.
   b. Till Compost into the top 6 inches of the soil.

G. Modified existing soil – soil within the root zone of existing established trees

1. Description of condition to be modified: Surface compaction near or above root limited levels in the upper soil horizon the result of traffic or other mechanical compaction.
2. Modifications:
   a. Remove the tops of all plants to be removed from the root zone. Remove sod with a walk behind sod cutter. Do not grub out the roots of plats to be removed.
   b. Use a pneumatic air knife to loosen the top 9 – 12 inches of the soil. Surface roots may move and separate from soil during this process but the bark on roots should

not be broken

1.) Pneumatic air knife shall be as manufactured by:
Concept Engineering Group, Inc., Verona, PA (412) 826-8800
or
Supersonic Air Knife, Inc., Allison Park, PA (866) 328 5723

c. Make chemical adjustment as recommended by the soil test and add 2 - 3 inches of Compost over the soil.
d. Using the pneumatic air knife, mix the Compost into the top 6 – 8 inches of the loosened soil.
e. Work in sections such that the entire process - including irrigation - can be completed in one day. Apply approximately one inch of water over the loosened soil at the completion of each day's work. Apply mulch or turf as indicated on the drawings within one week of the completion of work.

H. Modified existing soil – soil within tree pits

1. Perform percolation tests in tree pits prior to bringing trees to site.
2. Once holes have been dug per the contract drawings, fill sand pit with water to a depth of twelve inches and report the time required for all water to drain from hole.
   a. If drainage requires more than 24 hours, contractor shall install, at no additional cost to owner, a six-inch diameter perforated PVC chimney drain, a minimum forty-eight inches dee, gravel filled, covered with geotextile, set vertically at the lowest point of the bottom of the tree pit with a minimum two percent slope away from the tree.

2.8 PLANTING SOIL MIXES

A. General definition: Mixes of Existing Soil or Imported Topsoil, Coarse Sand, and or Compost to make a new soil that meets the project goals for the indicated planting area. These may be mixed off site or onsite and will vary in Mix components and proportions as indicated.

B. Planting Mix - moderately slow draining soil for trees and shrub beds

1. A Mix of Imported Topsoil, Coarse Sand and Compost. The approximate Mix ratio shall be:

Mix component	% by moist volume
Imported Topsoil unscreened	45-50%
Coarse sand	40-45%
Compost	10%

2. Final tested organic matter between 2.75 and 4% (by dry weight).
3. Mix the Coarse Sand and Compost together first and then add to the Topsoil. Mix with a loader bucket to loosely incorporate the Topsoil into the Coarse Sand/Compost Mix. DO NOT OVER MIX! Do not mix with a soil blending machine. Do not screen the soil. Clumps of Soil, Compost and Coarse Sand will be permitted in the overall Mix.
4. At the time of final grading, add fertilizer if required to the Planting Soil at rates recommended by the testing results for the plants to be grown.
5. Provide a two-gallon sample with testing data that includes recommendations for

chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time.

2.9 HEAVY DUTY PIPE DRAIN PIPE

A. Drain pipe shall be 4 inch diameter, perforated, PVC, Schedule 40 pipe. Holes in the pipe shall only be on the bottom quadrant. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. "T" and elbow joints shall be sanitary type connections. All joints shall be solvent welded. Submit manufacturers product literature for approval by the Landscape Architect.

1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.

B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

2.10 MEDIUM DUTY PIPE DRAIN PIPE

A. Drain pipe shall be 4 inch diameter, perforated, PVC, double wall (smooth interior wall / corrugated exterior wall) pipe. Holes in the pipe shall only be on the bottom quadrant. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. "T" and elbow joints shall be sanitary type connections. All joints shall be gasketed bell and spigot. Example source A -2000 by Contech Construction Products or approved equal. Submit manufacturers product literature for approval by the Landscape Architect.

1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.

B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

2.11 LIGHT DUTY PIPE DRAIN PIPE

A. Drain pipe shall be 4 inch diameter, perforated, HDPE, single wall corrugated exterior pipe. ASTM F405. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. All joints shall be gasketed bell and spigot. Example source ADS Single Wall Pipe by Advance Drainage Systems or approved equal. Submit manufacturers product literature for approval by the Landscape Architect.

1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.

B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out

riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

A. Prior to installation of Planting Soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

1. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
2. Confirm that surface all areas to be filled with Planting Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.
3. Confirm that no adverse drainage conditions are present.
4. Confirm that no conditions are present which are detrimental to plant growth.
5. Confirm that utility work has been completed per the drawings.
6. Confirm that irrigation work, which is shown to be installed below prepared soil levels, has been completed.

B. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action before proceeding.

3.2 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work.

B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Landscape Architect of any conflicts encountered.

3.3 GRADE AND ELEVATION CONTROL

A. Provide grade and elevation control during installation of Planting Soil. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.4 SITE PREPARATION

A. Excavate to the proposed subgrade. Maintain all required angles of repose of the adjacent materials as shown on the drawings or as required by this specification. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures

where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.

B. Remove all construction debris and material including any construction materials from the subgrade.

C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.

D. In areas where Planting Soil is to be spread, confirm subgrade has been scarified.

E. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.

1. At the end of each working day, clean up any soil or dirt spilled on any paved surface.
2. Any damage to the paving or site features or work shall be repaired at the Contractor's expense.

3.5 SOIL MOISTURE

A. Volumetric soil moisture level, in both the Planting Soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilt point and below field capacity for each type of soil texture within the following ranges.

Soil texture	**Permanent wilting point**	**Field capacity**
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

B. The Contractor shall confirm the soil moisture levels with a moisture meter (Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent). If moisture is found to be too low, the planting holes shall be filled with water and allowed to drain before starting any planting operations. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.6 EXISTING SOIL MODIFICATION

A. Follow the requirements for modifying existing soil as indicated in the soils test.

3.7 DRAIN PIPE INSTALLATION

1. Trench lines to depths and widths shown on plans.
2. Place 2 – 3 inches Coarse Sand as bedding for pipes.
3. Place pipe (holes facing down) to invert elevations shown on the plan.
   a. If pipe with holes on all sides is used drape a piece of 4 mil plastic 12 inches wide over top of pipe.
   b. Cover sides and top of pipe with Coarse Sand with min 4 inches of Coarse Sand cover above top of pipe.
   c. Backfill trench with Planting Soil compacted to same level as Planting Soil requirements.
4. Add cleanout pipe reaching the surface at the uphill end of each pipe run as shown on drawings.
5. Connect pipes to manhole or daylight outfall as shown on the drawings.

3.8 PLANTING SOIL AND PLANTING SOIL MIX INSTALLATION ON GRADE

A. Prior to installing any Planting Soil from stockpiles or Planting Soil Mixes blended off site, the Landscape Architect shall approve the condition of the subgrade and the previously installed subgrade preparation and the installation of subsurface drainage.

B. All equipment utilized to install or grade Planting Soils shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.

C. In areas of soil installation above existing subsoil, scarify the subgrade material prior to installing Planting Soil.

   1. Scarify the subsoil of the subgrade to a depth of 3 – 6 inches with the teeth of the back hoe or loader bucket, tiller or other suitable device.
   2. Immediately install the Planting Soil. Protect the loosened area from traffic. DO NOT allow the loosened subgrade to become compacted.
   3. In the event that the loosened area becomes overly compacted, loosen the area again prior to installing the Planting Soil.

D. Install the Planting Soil in 12 - 18 inch lifts to the required depths. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more Planting Soil by dragging the teeth of a loader bucket or backhoe across the soil surface to roughen the surface.

E. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil. Work in rows of lifts the width of the extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of each bed area.

F. Where possible place large trees first and fill Planting Soil around the root ball.

G. Installing soil with soil or mulch blowers or soil slingers shall not be permitted due to the over mixing and soil ped breakdown cause by this type of equipment.

H. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in Planting Soil. Each time equipment passes over the installed soil it shall reverse out of the area along the same path with the teeth of the bucket dropped to scarify the soil. Comply with the paragraph “Compaction Reduction” (section 3.9) in the event that soil becomes over compacted.

I. The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the compost material. The Contractor shall install the Planting Soil at a higher level to anticipate this reduction of Planting Soil volume. A minimum settlement of approximately 10 - 15% of the soil depth is expected. All grade increases are assumed to be as measured prior to addition of surface Compost till layer, mulch, or sod.

3.9 PLANTING SOIL AND PLANTING SOIL MIX INSTALLATION IN PLANTING AREAS OVER STRUCTURE

A. Protect Planting Soil Mix and Growing Media during storage to prevent drying or soil separation from rain and to prevent weed seed contamination. Pressure wash handling equipment prior to use to prevent contamination from weed seeds.

B. Install soil and drainage system after waterproofing by others according to manufacturer's written instructions and details. Install underlayment as specified. Install geotextile protection fabric and turn fabric up vertical flashing surfaces prior to placing Planting Soil Mix or Growing Media.

C. Drainage Layer: Place drainage layer parallel to slope. Abut sections of drainage layer. Overlap provided seams of attached filter fabric.

D. If required per structural weights, reduce soil depth as directed by Landscape Architect.

1. Geofoam Fill: Install geofoam-fill blocks in as few layers as possible with abutting edges and ends and with the long dimension of each block placed at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

2. Cover geofoam fill with separation geotextile before placing overlying growing medium.

E. Transport growing medium to structure or roof using stabilized hoisting equipment, blower truck, or cranes.

F. Remove all debris from container prior to installing growing medium.

G. Place planting soil mix or growing medium or temporary ballast immediately after layered system installation to prevent movement due to weather and construction activities.

1. After placing at specified depth, thoroughly water the entire planting area to preset and compact the growing media. Fill settled low areas with additional soil or medium. Repeat the compaction and filling process until area is of consistent thickness and settling no longer occurs.

H. Distribute growing medium evenly throughout the system or as shown on drawings, removing ay temporary ballast measures.

I. Access Boxes: Install access box at locations shown on Drawings. Install top of boxes level with the finish elevation of growing medium

3.10 COMPACTION REQUIREMENTS FOR INSTALLED OR MODIFIED PLANTING SOIL

A. Compact installed Planting Soil to the compaction rates indicated and using the methods approved for the soil mockup. Compact each soil lift as the soil is installed.

B. Existing soil that is modified by tilling, ripping or fracturing shall have a density to the depth of the modification, after completion of the loosening, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilting point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.

C. Installed Planting Soil Mix and re-spread existing soil shall have a soil density through the required depth of the installed layers of soil, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.

D. Planting Soil compaction shall be tested at each lift using a penetrometer calibrated to the mockup soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mockup shall be used to test installed soil throughout the work.

E. Maintain moisture conditions within the Planting Soil during installation or modification to allow for satisfactory compaction. Suspend operations if the Planting Soil becomes wet. Apply water if the soil is overly dry.

F. Provide adequate equipment to achieve consistent and uniform compaction of the Planting Soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction. Use the same equipment and methods of compaction used to construct the Planting Soil mockup.

G. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.

1. Light weight equipment such as trenching machines or motorized wheel barrows is permitted to pass over finished soil work.

2. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "Over Compaction Reduction" below.

3.11 OVER COMPACTION REDUCTION

A. Any soil that becomes compacted to a density greater than the specified density and/or the density in the approved mockup shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the Planting Soil is installed and approved.

B. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

3.12 INSTALLATION OF CHEMICAL ADDITIVES

A. Following the installation of each soil and prior to fine grading and installation of the Compost till layer, apply chemical additives as recommended by the soil test, and

appropriate to the soil and specific plants to be installed.

B. Types, application rates and methods of application shall be approved by the Landscape Architect prior to any applications.

3.13 FINE GRADING

A. The Landscape Architect shall approve all rough grading prior to the installation of Compost, fine grading, planting, and mulching.

B. Grade the finish surface of all planted areas to meet the grades shown on the drawings, allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph Planting Soil Installation, to anticipate settlement over the first year.

C. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.

D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Landscape Architect in the event that conditions make it impossible to achieve positive drainage.

E. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the drawings.

F. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inch deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

3.14 INSTALLATION OF COMPOST TILL LAYER

A. After Planting Soil Mixes are installed in planting bed areas and just prior to the installation of shrub or groundcover plantings, spread 3 – 4 inches of Compost over the beds and roto till into the top 4 - 6 inches of the Planting Soil. This step will raise grades slightly above the grades required in paragraph “Fine Grading”. This specification anticipates that the raise in grade due to this tilling will settle within a few months after installation as Compost breaks down. Additional settlement as defined in paragraph “Planting Soil and Planting Soil Mix installation” must still be accounted for in the setting of final grades.

3.15 CLEAN-UP

A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.

1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.

B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Landscape Architect seals are to remain on the trees and removed at the end of the warranty period.

1. Make all repairs to grades, ruts, and damage to the work or other work at the site.
2. Remove and dispose of all excess Planting Soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.16 PLANTING SOIL AND MODIFIED EXISTING SOIL PROTECTION

A. The Contractor shall protect installed and/or modified Planting Soil from damage including contamination and over compaction due to other soil installation, planting operations, and operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Utilize fencing and matting as required or directed to protect the finished soil work. Treat, repair or replace damaged Planting Soil immediately.

B. Loosen compacted Planting Soil and replace Planting Soil that has become contaminated as determined by the Landscape Architect. Planting Soil shall be loosened or replaced at no expense to the Owner.
   a. Till and restore grades to all soil that has been driven over or compacted during the installation of plants.
   b. Where modified existing soil has become contaminated and needs to be replaced, provide imported soil that is of similar composition, depth and density as the soil that was removed.

3.17 PROTECTION DURING CONSTRUCTION

A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers.

1. Maintain protection during installation until the date of plant acceptance (see specifications section – Planting). Treat, repair or replace damaged work immediately.
2. Provide temporary erosion control as needed to stop soil erosion until the site is stabilized with mulch, plantings or turf.

B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Landscape Architect shall determine when such cleaning, replacement or repair is satisfactory. Damage to existing trees shall be assessed by a certified arborist.

3.18 SUBSTANTIAL COMPLETION ACCEPTANCE

A. Upon written notice from the Contractor, the Landscape Architect shall review the work and make a determination if the work is substantially complete.

B. The date of substantial completion of the planting soil shall be the date when the Landscape Architect accepts that all work in Planting, Planting Soil, and Irrigation installation sections is

complete.

3.19 FINAL ACCEPTANCE / SOIL SETTLEMENT

A. At the end of the plant warrantee and maintenance period, (see Specification section 32 93 00 - Planting) the Landscape Architect shall observe the soil installation work and establish that all provisions of the contract are complete, and the work is satisfactory.

1. Restore any soil settlement and or erosion areas to the grades shown on the drawings. When restoring soil grades remove plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.

B. Failure to pass acceptance: If the work fails to pass final acceptance, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Landscape Architect.

END OF SECTION

SECTION 32 93 00 – PLANTING

PART 1 – GENERAL

1.1 SUMMARY

A. The scope of work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of plant (also known as "landscaping") complete as shown on the drawings and as specified herein.

B. The scope of work in this section includes, but is not limited to, the following:

1. Locate, purchase, deliver and install all specified plants.
2. Water all specified plants.
3. Mulch, fertilize, stake, and prune all specified plants.
4. Maintenance of all specified plants until the beginning of the warranty period.
5. Plant warranty.
6. Clean up and disposal of all excess and surplus material.
7. Maintenance of all specified plants during the warranty period.

1.2 CONTRACT DOCUMENTS

A. Shall consist of specifications and general conditions and the construction drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

A. Related Documents:
1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section
2. Related Specification Sections
   a. Section 32 91 00 - Planting Soil
3. Section 32 84 00 - Irrigation
4. Section 01 56 39 - Tree Protection and Plant Protection

B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the Landscape Architect.

1. State of California, Department of Food and Agriculture, Regulations for Nursery Inspections, Rules and Grading.
2. ANSI Z60.1 American Standard for Nursery Stock, most current edition.

3. ANSI A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.
4. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
   a. USDA - The Germplasm Resources Information Network (GRIN) http://www.ars-grin.gov/npgs/searchgrin.html
   b. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois; Most Current Edition.
   c. The New Sunset Western Garden Book, Oxmoor House, most current edition.
5. Pruning practices shall conform to recommendations “Structural Pruning: A Guide For The Green Industry” most current edition; published by Urban Tree Foundation, Visalia, California.
6. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign IL, most current edition.

1.4 VERIFICATION

A. All scaled dimensions on the drawings are approximate and diagrammatic. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Landscape Architect of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Landscape Architect.

B. In the case of a discrepancy in the plant quantities between the plan drawings and the plant call outs, list or plant schedule, the number of plant symbols or square footage of the planting bed actually drawn on the plan drawings shall be deemed correct and prevail.

1.5 PERMITS AND REGULATIONS

A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Landscape Architect in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Landscape Architect shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

1.7 CHANGES IN THE WORK

A. The Landscape Architect may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.

B. All changes in the work, notifications and contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

A. The Contractor, at their own cost, shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Landscape Architect, at the soonest as possible time that can be coordinated with other work and seasonal weather demands.

1.9 DEFINITIONS

All terms in this specification shall be as defined in the "Glossary of Arboricultural Terms" or as modified below.

A. Boxed trees: A container root ball package made of wood in the shape of a four-sided box.

B. Container plant: Plants that are grown in and/or are currently in a container including boxed trees.

C. Defective plant: Any plant that fails to meet the plant quality requirement of this specification.

D. End of Warranty Final Acceptance: The date when the Landscape Architect accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrent with each other.

E. Field grown trees (B&B): Trees growing in field soil for at least 12 months prior to harvest.

F. Healthy: Plants that are growing in a condition that expresses leaf size, crown density, color; and with annual growth rates typical of the species and cultivar's horticultural description, adjusted for the planting site soil, drainage and weather conditions.

G. Kinked root: A root within the root package that bends more than 90 degrees.

H. Maintenance: Actions that preserve the health of plants after installation and as defined in this specification.

I. Maintenance period: The time period, as defined in this specification, which the Contractor is to provide maintenance.

J. Normal: the prevailing protocol of industry standard(s).

K. Landscape Architect: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Landscape Architect may appoint other persons to review and approve any aspects of the work.

L. Reasonable and reasonably: When used in this specification relative to plant quality, it is intended to mean that the conditions cited will not affect the establishment or long term

stability, health or growth of the plant. This specification recognizes that it is not possible to produce plants free of all defects, but that some accepted industry protocols and standards result in plants unacceptable to this project.

When reasonable or reasonably is used in relation to other issues such as weeds, diseased, insects, it shall mean at levels low enough that no treatment would be required when applying recognized Integrated Plant Management practices.

This specification recognizes that some decisions cannot be totally based on measured findings and that professional judgment is required. In cases of differing opinion, the Landscape Architect's expert shall determine when conditions are judged as reasonable.

M. Root ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.

N. Root ball package. The material that surrounds the root ball during shipping. The root package may include the material in which the plant was grown, or new packaging placed around the root ball for shipping.

O. Root collar (root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.

P. Shrub: Woody plants with mature height approximately less than 15 feet.

Q. Spade harvested and transplanted: Field grown trees that are mechanically harvested and immediately transplanted to the final growing site without being removed from the digging machine.

R. Stem: The trunk of the tree.

S. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Landscape Architect accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project.

T. Stem girdling root: Any root more than ¼ inch diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as Stem Girdling that have, or are likely to have in the future, root to trunk bark contact.

U. Structural root: One of the largest roots emerging from the root collar.

V. Tree: Single and multi-stemmed plants with mature height approximately greater than 15 feet.

1.10 SUBMITTALS

A. See contract general conditions for policy and procedure related to submittals.

B. Submit all product submittals a minimum of 60 days prior to installation of plantings.

C. Shop drawings of root barrier layout.

D. Product data: Submit manufacturer product data and literature describing all products required by this section to the Landscape Architect for approval. Provide submittal eight weeks before the installation of plants.

E. Plant growers' certificates: Submit plant growers' certificates for all plants indicating that each meets the requirements of the specification, including the requirements of tree quality, to the Landscape Architect for approval. Provide submittal eight weeks before the installation of plants.

F. Samples: Submit samples of each product and material where required by the specification to the Landscape Architect for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

G. Plant sources: Submit sources of all plants as required by Article – "Selection of Plants" to the Landscape Architect for approval.
   1. Include each plant's botanical name, size and quantity.
      a. Requests for substitutions due to unavailability must be made in writing.
      b. Substitutions may not be made without approval of the Architect.
      c. Contractor shall notify Architect 24 hours in advance of delivery of plant materials and shall submit an itemized list of plants in each delivery.

H. Photographs of Trees: Submit photographs of 24-inch boxed and larger trees available for selection at the nursery(ies) a minimum of the seven days prior to the tree tagging scheduled at the nursery.
   1. Label each photo with nursery name, plant name and size.

I. Close out submittals: Submit to the Landscape Architect for approval.
   1. Plant maintenance data and requirements.

1.11 OBSERVATION OF THE WORK

A. The Landscape Architect may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.

B. The Landscape Architect shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Landscape Architect shall be afforded sufficient time to schedule visit to the site. Failure of the Landscape Architect to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

   1. SITE CONDITIONS PRIOR TO THE START OF PLANTING: review the soil and drainage conditions.

   2. COMPLETION OF TREE LAYOUT. Review of the layout and facing of trees. Trees to be positioned in planting holes or pots and reviewed by Landscape Architect prior to backfill.

   3. COMPLETION OF THE PLANT LAYOUT STAKING OR CONTAINER PLACEMENT: Review of the plant layout.

   4. PLANT QUALITY: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.

5. COMPLETION OF THE PLANTING: Review the completed planting.

1.12 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre-construction meeting with the Landscape Architect at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

B. Notify the Landscape Architect a minimum of 72 hours in advance of all observations of planting.

C. Notify the Landscape Architect a minimum of 72 hours in advance of nursery visits to select trees.

D. Notify the Landscape Architect a minimum of seven days prior to the completion of planting walkthrough.

1.13 QUALITY ASSURANCE

A. Substantial Completion Acceptance - Acceptance of the work prior to the start of the warranty period:

1. Once the Contractor completes the installation of all items in this section, the Landscape Architect will observe all work for Substantial Completion Acceptance upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of the observation.

2. Substantial Completion Acceptance by the Landscape Architect shall be for general conformance to specified size, character and quality and not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.

3. Any plants that are deemed defective as defined under the provisions below shall not be accepted.

B. The Landscape Architect will provide the Contractor with written acknowledgment of the date of Substantial Completion Acceptance and the beginning of the warranty period and plant maintenance period (if plant maintenance is included).

C. Contractor’s Quality Assurance Responsibilities: The Contractor is solely responsible for quality control of the work.

D. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work, including the handling and planting of large specimen trees in urban areas. The same firm shall install planting soil (where applicable) and plant material.

1. The bidders list for work under this section shall be approved by the Landscape Architect.

2. Installer Field Supervision: When any planting work is in progress, installer shall maintain, on site, a full-time supervisor who can communicate in English with the Landscape Architect.

3. Installer’s field supervisor shall have a minimum of five years experience as a field supervisor installing plants and trees of the quality and scale of the proposed project and can communicate in English with the Landscape Architect.

4. The installer's crew shall have a minimum of 3 years experienced in the installation of Planting Soil, Plantings, and Irrigation (where applicable) and interpretation of soil plans, planting plans and irrigation plans.
5. Submit references of past projects, employee training certifications that support that the Contractors meets all of the above installer qualifications and applicable licensures.

1.14 PLANT WARRANTY

A. Plant Warranty:

1. The Contractor agrees to replace poor, inadequate, defective materials and defective plants. The Landscape Architect shall make the final determination if plants meet these specifications or that plants are defective.

   Plants warranty shall begin on the date of Substantial Completion Acceptance and continue for the following periods, classed by plant type:
   a. Trees – One Year.
   b. Palm Trees – Two Years
   c. Shrubs – One Year
   d. Ground cover and perennial flower plants – One Year.
   e. Bulbs, annual flower and seasonal color plants – for the period of expected bloom or primary display.
2. When the work is accepted in parts, the warranty periods shall extend from each of the partial Substantial Completion Acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of plant warranty, shall terminate at one time.
3. All plants shall be warrantied to meet all the requirements for plant quality at installation in this specification. Defective plants shall be defined as plants not meeting these requirements. The Landscape Architect shall make the final determination that plants are defective.
4. Plants determined to be defective shall be removed within fifteen days upon notification by the Landscape Architect and replaced without cost to the Owner, within fifteen days or as soon as weather conditions permit and within the specified planting period.
5. Any work required by this specification or the Landscape Architect during the progress of the work, to correct plant defects including the removal of roots or branches, or planting plants that have been bare rooted during installation to observe for or correct root defects shall not be considered as grounds to void any conditions of the warranty. In the event that the Contractor decides that such remediation work may compromise the future health of the plant, the plant or plants in question shall be rejected and replaced with plants that do not contain defects that require remediation or correction.
6. The Contractor is exempt from replacing plants, after Substantial Completion Acceptance and during the warranty period, that are removed by others, lost or damaged due to occupancy of project, lost or damaged by a third party, vandalism, or any natural disaster.
7. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all

necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.

8. The warranty of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended warranty period, the Landscape Architect may elect one more replacement items or credit for each item. These tertiary replacement items are not protected under a warranty period.
9. During and by the end of the warranty period, remove all tree wrap, ties, and guying unless agreed to by the Landscape Architect to remain in place. All trees that do not have sufficient caliper to remain upright, or those requiring additional anchorage in windy locations, shall be staked or remain staked, if required by the Landscape Architect.

B. End of Warranty Final Acceptance - Acceptance of plants at the end of the warranty period.

1. At the end of the warranty period, the Landscape Architect shall observe all warranted work, upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date for final observation.
2. End of Warranty Final Acceptance will be given only when all the requirements of the work under this specification and in specification sections Planting Soil and Irrigation have been met.

1.15 SELECTION AND OBSERVATION OF PLANTS

A. The Landscape Architect may review all plants subject to approval of size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.

B. Plant Selection: The Landscape Architect reserves the right to select and observe all plants at the nursery prior to delivery and to reject plants that do not meet specifications as set forth in this specification. If a particular defect or substandard element can be corrected at the nursery, as determined by the Landscape Architect, the agreed upon remedy may be applied by the nursery or the Contractor provided that the correction allows the plant to meet the requirements set forth in this specification. Any work to correct plant defects shall be at the contractor’s expense.
   1. The Landscape Architect may make invasive observation of the plant’s root system in the area of the root collar and the top of the root ball in general in order to determine that the plant meets the quality requirements for depth of the root collar and presence of roots above the root collar. Such observations will not harm the plant.
   2. Corrections are to be undertaken at the nursery prior to shipping.

C. The Contractor shall bear all cost related to plant corrections.

D. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the Owner.

E. Submit to the Landscape Architect, for approval, plant sources including the names and locations of nurseries proposed as sources of acceptable plants, and a list of the plants they will provide. The plant list shall include the botanical and common name and the size at the

time of selection. Observe all nursery materials to determine that the materials meet the requirements of this section.

F. Trees shall be purchased from the growing nursery. Re-wholesale plant suppliers shall not be used as sources unless the Contractor can certify that the required trees are not directly available from a growing nursery. When Re-wholesale suppliers are utilized, the Contractor shall submit the name and location of the growing nursery from where the trees were obtained by the re-wholesale seller. The re-wholesale nursery shall be responsible for any required plant quality certifications.

G. The Contractor shall require the grower or re-wholesale supplier to permit the Landscape Architect to observe the root system of all plants at the nursery or job site prior to planting including random removal of soil or substrate around the base of the plant. Observation may be as frequent and as extensive as needed to verify that the plants meet the requirements of the specifications and conform to requirements.

H. Each tree shall have a numbered seal applied by the Contractor. The seal shall be placed on a lateral branch on the north side of the tree. The seal shall be a tamper proof plastic seal bearing the Contractors name and a unique seven-digit number embossed on the seal.
   1. Do not place seals on branches that are so large that there is not sufficient room for the branch growth over the period of the warranty.

I. The Landscape Architect may choose to attach their seal to each plant, or a representative sample. Viewing and/or sealing of plants by the Landscape Architect at the nursery does not preclude the Landscape Architect’s right to reject material while on site. The Contractor is responsible for paying any up charge for the Landscape Architect to attach their seal to specific plants.

J. The Contractor shall coordinate up to two tree selection visits with local nurseries for the Landscape Architect to select trees and attach their seal to each tree.
   1. Each tree selection visit shall be defined as the Landscape Architect traveling to a single nursery or a maximum of two nurseries within ten miles distance from one another.
   2. A local nursery shall be defined as a nursery within fifty miles of downtown Los Angeles, California.
   3. Nurseries selected by the contractor shall stock and have available for review and tagging 200 percent the quantity of the specified tree.
   4. No photographs will be accepted for the final selection of trees.
   5. Failure to comply with the tree selection visit requirements listed above shall make the Contractor responsible for reimbursing the Landscape Architect for the nursery visit(s) at their current hourly billing rate plus transportation costs. No further tree selection visits will be scheduled until this charge has been paid and received.

K. Where requested by the Landscape Architect, submit photographs of plants or representative samples of plants. Photographs shall be legible and clearly depict the plant specimen. Each submitted image shall contain a height reference, such as a measuring stick. The approval of plants by the Landscape Architect via photograph does not preclude the Landscape Architect's right to reject material while on site.

1.16 PLANT SUBSTITUTIONS FOR PLANTS NOT AVAILABLE

A. Submit all requests for substitutions of plant species, or size to the Landscape Architect, for approval, prior to purchasing the proposed substitution. Request for substitution shall be accompanied with a list of nurseries contacted in the search for the required plant and a record of other attempts to locate the required material. Requests shall also include sources of plants found that may be of a smaller or larger size, or a different shape or habit than specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications, but which may be available for substitution.

1.17 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Landscape Architect, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.

1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Landscape Architect in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Landscape Architect of such conditions, he/she shall remain responsible for plant material under the warranty clause of the specifications.

B. It is the responsibility of the Contractor to be familiar with the local growing conditions, and if any specified plants will be in conflict with these conditions. Report any potential conflicts, in writing, to the Landscape Architect.

C. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.

1. Planting operations shall not begin until such time that the irrigation system is completely operational for the area(s) to be planted, and the irrigation system for that area has been preliminarily observed and approved by the Landscape Architect.

D. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.

1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather, such as rain or snow or during extremely hot, cold or windy conditions.

1.18 PLANTING AROUND UTILITIES

A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.

C. Notification of *DigAlert*, *811*, is required for all planting areas: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the *DigAlert*

PART 2 – PRODUCTS

2.1 PLANTS: GENERAL

A. Standards and measurement: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents.

1. All plants including the root ball dimensions or container size to trunk caliper ratio shall conform to ANSI Z60.1 “American Standard for Nursery Stock” latest edition, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.
2. Plants larger than specified may be used if acceptable to the Landscape Architect. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
3. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.

B. Proper Identification: All trees shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by genus, species, variety and cultivar.

C. Compliance: All trees shall comply with federal and state laws and regulations requiring observation for plant disease, pests, and weeds. Observation certificates required by law shall accompany each shipment of plants.

D. All plants and planting materials that meet or exceed specifications of Federal, State, and County laws requiring inspection for plant disease or insect control.

E. Provide plants that are true to name. Tag one of each bundle or lot with the name and size of plants in accordance with the standards of practice the American Nursery & Landscape Association.

F. Botanical names shall take precedence over common names.

G. Plants shall be in conformance with the California State Department of Agriculture's regulation for nursery inspections, rules, and ratings. Plants shall be healthy, vigorous, and free of insect infestations, plant diseases, sunscalds, frost burns, abrasions, or other disfigurement. Plants shall be grown in climatic conditions similar to that of the planting site, and well hardened off. Plants shall have vigorous fibrous root systems which are not rootbound or pot bound. The Architect is the sole judge as to acceptability of plant material.

H. Plant Quality:

1. **General**: Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant
2. **Plant quality above the soil line:**
   a. Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves normal to the plant type specified. Tree quality be

accepted by the Landscape Architect:

1.) Crown: The form and density of the crown shall be typical for a young specimen of the species or cultivar pruned to a central and dominant leader.
   a.) Crown specifications do not apply to plants that have been specifically trained in the nursery as topiary, espalier, multi-stem, clump, or unique selections such as contorted or weeping cultivars.
2.) Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.
3.) Branches: Shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.
   a.) Main branches shall be distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
   b.) Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.
   c.) The attachment of the largest branches (scaffold branches) shall be free of included bark.
4.) Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).
5.) Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter. Clear trunk should be no more than 40% of the total height of the tree.

b. Trees shall have one central leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present.
   1.) All trees are assumed to have one central leader trees unless a different form is specified in the plant list or drawings.
c. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
d. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stake may be used to maintain a straight leader in the upper half of the tree.

3. Plant quality at or below the soil line:

a. Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:

   1.) The roots shall be reasonably free of scrapes, broken or split wood.
   2.) The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high quality root system are not

considered injuries.

3.) A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
    a.) Plants with structural roots on only one side of the trunk (J roots) shall be rejected.
4.) The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.
5.) The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots from nursery production practices.
    a.) Plant Grower Certification: The final plant grower shall be responsible to have determined that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous production system used practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage, if needed, to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of stem girdling and kinked roots as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.
6.) At time of observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

I. Submittals: Submit for approval the required plant quality certifications from the grower where plants are to be purchased, for each plant type. The certification must state that each plant meets all the above plant quality requirements.
    1. The grower's certification of plant quality does not prohibit the Landscape Architect from observing any plant or rejecting the plant if it is found to not meet the specification requirements.

2.2 ROOT BALL PACKAGE OPTIONS: The following root ball packages are permitted. Specific root ball packages shall be required where indicated on the plant list or in this specification. Any type of root ball packages that is not specifically defined in this specification shall not be permitted.

A. BALLED AND BURLAPPED PLANTS

1. All Balled and Burlapped Plants shall be field grown, and the root ball packaged in a burlap and twine and/or burlap and wire basket package.

2. Plants shall be harvested with the following modifications to standard nursery practices.

a. Prior to digging any tree that fails to meet the requirement for maximum soil and roots above the root collar, carefully removed the soil from the top of the root ball of each plant, using hand tools, water or an air spade, to locate the root collar and attain the soil depth over the structural roots requirements. Remove all stem girdling roots above the root collar. Care must be exercised not to damage the surface of the root collar and the top of the structural roots.

b. Trees shall be dug for a minimum of 4 weeks and a maximum of 52 weeks prior to shipping. Trees dug 4 to 52 weeks prior to shipping are defined as hardened-off. Digging is defined as cutting all roots and lifting the tree out of the ground and either moving it to a new location in the nursery or placing it back into the same hole. Tress that are stored out of the ground shall be placed in a holding area protected from extremes of wind and sun with the root ball protected by covering with mulch or straw and irrigated sufficiently to keep moisture in the root ball above wilt point and below saturation

c. If wire baskets are used to support the root ball, a “low profile” basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less than 4 inches and no greater than 8 inches below the shoulder of the root ball package.

   1.) At nurseries where sandy soils prevent the use of “low profile baskets”, baskets that support the entire root ball, including the top, are allowable.

d. Twine and burlap used for wrapping the root ball package shall be natural, biodegradable material. If the burlap decomposes after digging the tree then the root ball shall be re-wrapped prior to shipping if roots have not yet grown to keep root ball intact during shipping.

B. SPADE HARVESTED AND TRANSPLANTED
   1. Spade Harvested and Transplanted Plants shall meet all the requirements for field grown trees. Root ball diameters shall be of similar size as the ANSI Z60.1 requirements for Balled and Burlapped plants.
   2. Trees shall be harvested prior to leafing out (bud break) in the spring or during the fall planting period except for plants know to be considered as fall planting hazards. Plants that are fall planting hazards shall only be harvested prior to leafing out in the spring.
   3. Trees shall be moved and planted within 48 hours of the initial harvesting and shall remain in the spade machine until planted.

C. CONTAINER (INCLUDING ABOVE-GROUND FABRIC CONTAINERS AND BOXES) PLANTS
   1. Container plants may be permitted only when indicated on the drawing, in this specification, or approved by the Landscape Architect.
   2. Provide plants shall be established and well rooted in removable containers.
   3. Container class size shall conform to ANSI Z60.1 for container plants for each size and type of plant.
   4. Five gallon and larger container plants shall have been grown in containers for a minimum of six months and maximum of two years. Plants shall be furnished on site free of pests or diseases and exhibit healthy growth.

2.3 PALMS

A. Except as modified below or where the requirements are not appropriate to the specification of palms, palms shall meet all the requirements of the plant quality section above.

B. Defronding, tying, and hedging:
   1. In preparing palm trees for relocation, all dead fronds shall be removed.
   2. All remaining fronds above horizontal shall be lifted up and tied together around the crown in an upright position. Up to 2/3 of the oldest live fronds can be removed; all fronds can be removed on Sabal palms. Do not tie too tightly, bind or injure the bud. Jute binder twine shall be used in tying up the fronds; wire will not be permitted. Fronds shall be untied immediately after planting.

C. Digging the root ball:
   1. When digging out the root ball, no evacuation shall be done closer than six to thirty-six inches, dependent on the species, to the trunk at ground level and the excavation shall extend below the major root system to a minimum depth of 3.5 feet. The bottom of the root ball shall be cut off square and perpendicular to the trunk below the major root system.

D. The Contractor shall not free-fall, drag, roll or abuse the tree or put a strain on the crown (bud area) at any time. A protective device shall be used around the trunk of the tree while lifting and relocating so as not to injure the bud, or scar or skin the trunk in any way.

E. Palms shall be grown under climatic conditions similar to those in locality of project.

F. Unless otherwise stated on Plans, Washingtonia palms are to be skinned, with straight trunks.

G. Palms must be planted within 24 hours of digging.

2.4 PLANTING SOIL

A. Planting Soil as used in this specification means the soil at the planting site or imported as modified and defined in specification Section Planting Soil. If there is no Planting Soil specification, the term Planting Soil shall mean the soil at the planting site within the planting hole.

2.5 MULCH

A. Mulch shall be "Walk on" grade, coarse, ground, from tree and woody brush sources. The size range shall be a minimum (less than 25% or less of volume) fine particles 3/8 inch or less in size, and a maximum size of individual pieces (largest 20% or less of volume) shall be approximately 1 to 1-1/2 inch in diameter and maximum length approximately 4 to 8". Pieces larger than 8 inch long that are visible on the surface of the mulch after installation shall be removed.

   1. It is understood that mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Landscape Architect.
   2. Shredded lumber products will not be accepted.

B. Subject to compliance with requirements, provide products by the following:
   1. Walk On Bark, Sequoia Horticultural Products, PO Box 963, Dinuba, CA 93618; 559-

591-1177.
1.) ¼ inch to 3 inches, fibrous, bark nuggets and cambium wood,
2.) Fir or Pine

2. Forest Floor Mulch, Aguinaga Green, 410 West Grove Avenue, Orange, CA 92865; 1877-OC-MULCH
3. Approved Equal

2.6 TREE STAKING AND GUYING MATERIAL

A. Tree guying
1. Flexible vinyl tree ties meeting ASTM-D-412 standards for tensile and elongation strength. Material shall be black.
2. Each tie shall be a single piece, not multiple ties joined together.
3. Subject to compliance with requirements, provide products by the following:
a. VIT Cinch Tie
b. VIT Cinch Belt (larger trees)
c. Villa Root Barrier E-Z Band
d. Approved Equal

B. Stakes shall be lodge pole pine stakes free of knots and of diameters and lengths appropriate to the size of plant as required to adequately support the plant.
1. Fully treated with CuNap, ACQ or other non-arsenic wood preservative.
2. Do not split stakes.
3. Sizes
1.) Two inch diameter (nom.) by 10 foot long for 24-inch box and smaller Trees
2.) Three inch diameter (nom.) by 12 foot long for 36-inch box trees

C. Guying Hardware:
1. Wire: Pliable 1/8” galvanized steel cable.
2. Hose: 1/2" new black rubber hose.
3. Turnbuckles: galvanized or dip-painted, size as required.
4. Cable clamps: galvanized, size as required.
5. Safety Sleeve: 1/2" white PVC full length of wire.
6. Steel Guy Anchor: Duckbill Anchor by Foresight Products (800) 325-5360; Platypus Tree Anchoring Systems (866) 752-8478, or equal. Size as needed.

D. Submit manufacturer’s product data for approval.

2.7 TREE BARK PROTECTOR

A. Tree Bark Protectors shall be gray, brown color extruded resin mesh, 4 inches in diameter, 5 feet long, 1.52 millimeters thick UV inhibited polyethylene.

B. Subject to compliance with requirements, provide products by the following:
1. Industrial Netting, Minneapolis, MN.
2. Approved Equal

C. Fasten the split side of the Tree Bark Protector together in three places with black plastic tape.

D. Submit manufacturers’ product data for approval.

2.8 WATERING BAGS

A. Plastic tree watering bags holding a minimum of 15 gallons of water and with a slow drip hole(s) water release system, specifically designed to water establishing trees. Water should release over a several day period, not within a few hours

B. Subject to compliance with requirements, provide products by the following:
   1. Treegator Irrigation Bags sized to the appropriate model for the requirements of the plant, manufactured by Spectrum Products, Inc., Youngsville, NC 27596.
   2. Ooze Tube sized to the appropriate model for the requirements of the plant, manufactured by Engineered Water Solutions, Atlanta, GA.
   3. Or approved equal.

C. Submit manufacturer's product data for approval.

2.9 CHEMICAL OR BIOLOGICAL ADDITIVES

A. PLANT TABLETS
   1. 7-gram planting tablet designed for 12 month slow release.
   2. 12-8-8 NPK, 20% humus, 4% humic acids, 3.5% sulfur, 2% iron, micronutrients.

B. Submit manufacturers' product data for approval.

2.10 WATER

A. Furnished Contractor if Owner is unable to furnish acceptable water.

B. Transport by Contractor as required.

2.11 METAL EDGING

A. Landscape edging
   1. Border King or Permaloc
   2. One-quarter inch by five inches.
   3. Black
   4. Anchor stake loops and fifteen-inch tapered metal anchoring stakes.

B. Subject to compliance with requirements, provide products by the following:
   1. Border Concepts (800) 845-3343
   2. Permaloc
   3. Approved Equal

2.12 DRAINAGE MATERIAL

A. 3/8" Crushed Angular Rock
   1. 95% -100% passing through a 3/8" screen.
   2. 0-5% passing through No. 8 mesh.
   3. 80-100# per cubic yard.

B. Submit manufacturers' product data for approval.

2.13 DRAIN PIPES (DRAINAGE SUMP)

A. Sub-Surface perforated or non-perforated as indicated on Plans, size and type noted, manufactured by Lasco, National Diversified Sales (NDS) or Advanced Drainage Systems, Inc. Perforated pipe shall be completely wrapped with a water permeable nylon screen that is lapped and welded around the pipe, and surrounded by minimum 4" thickness of coarse sand or gravel, unless otherwise noted on Plans.

B. Planter Area Drainpipe and Fixtures: National Diversified Sales (NDS) SDR 35 fittings and SDR 35 drainpipes with specified grates, color black, and size and type per plan. NDS, Newbury Park, California, telephone: (800) 726-1994.

2.14 PALM TREE VENT

A. 4” ID single-wall, corrugated, polyethylene, perforated (slots) drain pipe with soil separator sock. ADS-401 with sock, or equal.

B. 4” round PVC drain grate. Color: to be selected.

2.15 SOIL SEPARATOR

A. Nonwoven polypropylene fabric
   1. needle-punched
   2. UV Resistance of 70%
   3. AOS of 70 US Standard sieve
   4. Water flow rate of 110 gpm/ft2.

B. Subject to compliance with requirements, provide products by the following:
   1. Geotex 701, manufactured by Propex,
   2. Approved Equal

C. Submit manufacturers’ product data for approval.

2.16 WEED CONTROL FABRIC

A. Spun-bonded polypropylene with UV inhibitors, non-degrading geotextile fabric that blocks 95% of weed growth and is permeable to air, water, gasses and fertilizer. Typar 3301 or equal.
   a. Properties:
      1.) Unit Weight: 3.0 oz/yds2
      2.) Tensile Strength: 135 pounds
      3.) Puncture Strength: 35 pounds
      4.) Air Opening Size: 60/70 equivalent sieve
      5.) Elongation at Break: <70%
      6.) Trap Tear: 50 pounds
      7.) Flux: 70 gal/ft2/min
      8.) Permittivity: 1.2 sec-2
      9.) Color: Black

B. Submit manufacturers’ product data for approval.

2.17 ROOT BARRIER

A. A root barrier is required when the center of the trunk of the tree is within six feet of adjacent pavement, walls, curbs, building or other structure.

B. Polyethylene (0.08 inch thick) or polypropylene (2.032 - 2.16 mm thick) barrier
   1. Self-locking joiners
   2. ½” raised 90 degree molded root deflecting ribs
   3. Ground lock tabs
   4. Double top edge
   5. UV inhibitors.

6. Twenty-four inches tall by twelve feet long unless otherwise stated

C. Submit manufacturers' product data for approval.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

A. Examine the surface grades and soil conditions to confirm that the requirements of the Specification Section – Planting Soil - and the soil and drainage modifications indicated on the Planting Soil Plan and Details (if applicable) have been completed. Notify the Landscape Architect in writing of any unsatisfactory conditions.

3.2 DELIVERY, STORAGE AND HANDLING

A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.

1. All plant materials must be available for observation prior to planting.

2. Using a soil moisture meter, periodically check the soil moisture in the root balls of all plants to assure that the plants are being adequately watered. Volumetric soil moisture shall be maintained above wilting point and below field capacity for the root ball substrate or soil.

B. Do not deliver more plants to the site than there is space with adequate storage conditions. Provide a suitable remote staging area for plants and other supplies.

1. The Landscape Architect or Contractor shall approve the duration, method and location of storage of plants.

C. Provide protective covering over all plants during transporting.

3.3 PLANTING SEASON

A. Planting shall only be performed when weather and soil conditions are suitable for planting the materials specified in accordance with locally accepted practice.

B. Install plants during the planting time as described below unless otherwise approved in writing by the Landscape Architect. In the event that the Contractor request planting outside the dates of the planting season, approval of the request does not change the requirements of the warranty.

1. Seeding and Hydro-seeding -- November to December

3.4 ADVERSE WEATHER CONDITIONS

A. No planting shall take place during extremely hot, dry, windy or freezing weather.

3.5 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the

work.

B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Landscape Architect of any conflicts encountered.

3.6 LAYOUT AND PLANTING SEQUENCE

A. Relative positions of all plants and trees are subject to approval of the Landscape Architect.

B. Notify the Landscape Architect, one (1) week prior to layout. Layout all individual tree and shrub locations. Place plants above surface at planting location or place a labeled stake at planting location. Layout bed lines with paint for the Landscape Architect's approval. Secure the Landscape Architect's acceptance before digging and start of planting work.

C. When applicable, plant trees before other plants are installed.

D. It is understood that plants are not precise objects and that minor adjustments in the layout will be required as the planting plan is constructed. These adjustments may not be apparent until some or all of the plants are installed. Make adjustments as required by the Landscape Architect including relocating previously installed plants.

3.7 SOIL PROTECTION DURING PLANT DELIVERY AND INSTALLATION

A. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.

1. Where possible deliver and plant trees that require the use of heavy mechanized equipment prior to final soil preparation and tilling. Where possible, restrict the driving lanes to one area instead of driving over and compacting a large area of soil.

2. Till to a depth of 6 inches, all soil that has been driven over during the installation of plants.

3.8 SOIL MOISTURE

A. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	**Permanent wilting point**	**Field capacity**
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and

Instruments, or approved equivalent.

B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.9 INSTALLATION OF PLANTS: GENERAL

A. Observe each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Notify the Landscape Architect of any condition observed.

B. No more plants shall be distributed about the planting bed area than can be planted and watered on the same day.

C. The root system of each plant, regardless of root ball package type, shall be observed by the Contractor, at the time of planting to confirm that the roots meet the requirements for plant root quality in Part 2 Products: Plants General: Plant Quality. The Contractor shall undertake at the time of planting, all modifications to the root system required by the Landscape Architect to meet these quality standards.

1. Modifications, at the time of planting, to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the Landscape Architect may choose to reject the plant rather than permitting the modification.

2. Any modifications required by the Landscape Architect to make the root system conform to the plant quality standards outlined in Part 2 Products: Plants General: Quality, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.

3. The resulting root ball may need additional staking and water after planting. The Landscape Architect may reject the plant if the root modification process makes the tree unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty

4. The Contractor remains responsible to confirm that the grower has made all required root modifications noted during any nursery observations.

D. Container and Boxed Root Ball Shaving: The outer surfaces of ALL plants in containers and boxes, including the top, sides and bottom of the root ball shall be shaved to remove all circling, descending, and matted roots. Shaving shall be performed using saws, knives, sharp shovels or other suitable equipment that is capable of making clean cuts on the roots. Shaving shall remove a minimum of one inch of root mat or up to 2 inches as required to remove all root segments that are not growing reasonably radial to the trunk.

E. Exposed Stem Tissue after Modification: The required root ball modifications may result in stem tissue that has not formed trunk bark being exposed above the soil line. If such condition occurs, wrap the exposed portion of the stem in a protective wrapping with a white filter fabric. Secure the fabric with biodegradable masking tape. DO NOT USE string, twine, green nursery ties or any other material that may girdle the trunk if not removed.

F. Excavation of the Planting Space: Using hand tools or tracked mini-excavator, excavate the planting hole into the Planting Soil to the depth of the root ball measured after any root ball modification to correct root problems, and wide enough for working room around the root

ball or to the size indicated on the drawing or as noted below.

1. For trees and shrubs planted in soil areas that are NOT tilled or otherwise modified to a depth of at least 12 inches over a distance of more than 10 feet radius from each tree, or 5 feet radius from each shrub, the soil around the root ball shall be loosened as defined below or as indicated on the drawings.
   a. The area of loosening shall be a minimum of 3 times the diameter of the root ball at the surface sloping to 2 times the diameter of the root ball at the depth of the root ball.
   b. Loosening is defined as digging into the soil and turning the soil to reduce the compaction. The soil does not have to be removed from the hole, just dug, lifted and turned. Lifting and turning may be accomplished with a tracked mini excavator, or hand shovels.
2. If an auger is used to dig the initial planting hole, the soil around the auger hole shall be loosened as defined above for trees and shrubs planted in soil areas that are NOT tilled or otherwise modified.
3. The measuring point for root ball depth shall be the average height of the outer edge of the root ball after any required root ball modification.
4. If motorized equipment is used to deliver plants to the planting area over exposed planting beds, or used to loosen the soil or dig the planting holes, all soil that has been driven over shall be tilled to a depth of 6 inches.

G. For trees to be planted in prepared Planting Soil that is deeper than the root ball depth, compact the soil under the root ball using a mechanical tamper to assure a firm bedding for the root ball. If there is more than 12 inches of planting soil under the root ball excavate and tamp the planting soil in lifts not to exceed 12 inches.

H. Set top outer edge of the root ball at the average elevation of the proposed finish. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball.

I. The Landscape Architect may request that plants orientation be rotated when planted based on the form of the plant.

J. Backfill the space around the root ball with the same planting soil or existing soil that was excavated for the planting space. See Specification Section Planting Soil, for requirements to modify the soil within the planting bed.

K. Brace root ball by tamping Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density, standard proctor or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.

   1. When the planting hole has been backfilled to three quarters of its depth, water shall be poured around the root ball and allowed to soak into the soil to settle the soil. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill

continued until the planting soil is brought to grade level.

L. Where indicated on the drawings, build a 4 inch high, level berm of Planting Soil around the outside of the root ball to retain water. Tamp the berm to reduce leaking and erosion of the saucer.

M. Thoroughly water the Planting Soil and root ball immediately after planting.

N. Remove all nursery plant identification tags and ribbons as per Landscape Architect instructions. The Landscape Architect's seals are to remain on plants until the end of the warranty period.

O. Remove corrugated cardboard trunk protection after planting.

P. Follow additional requirements for the permitted root ball packages.

3.10 PERMITTED ROOT BALL PACKAGES AND SPECIAL PLANTING REQUIREMENTS

A. The following are permitted root ball packages and special planting requirements that shall be followed during the planting process in addition to the above General planting requirements.

B. BALLED AND BURLAPPED PLANTS

1. After the root ball has been backfilled, remove all twine and burlap from the top of the root ball. Cut the burlap away; do not fold down onto the Planting Soil.

2. If the plant is shipped with a wire basket that does not meet the requirements of a "Low Rise" basket, remove the top 6 - 8 inches of the basket wires just before the final backfilling of the tree.

3. Earth root balls shall be kept intact except for any modifications required by the Landscape Architect to make root package comply with the requirement in Part 2 Products.

C. SPADE HARVESTED AND TRANSPLANTED PLANTS

1. After installing the tree, loosen the soil along the seam between the root ball and the surrounding soil out to a radius from the root ball edge equal to the diameter of the root ball to a depth of 8 - 10 inches by hand digging to disturb the soil interface.
2. Fill any gaps below this level with loose soil.

D. CONTAINER (INCLUDES BOXED AND ABOVE-GROUND FABRIC CONTAINERS) PLANTS

1. This specification assumes that most container plants have significant stem girdling and circling roots, and that the root collar is too low in the root ball.

2. Remove the container.

3. Perform root ball shaving as defined in Installation of Plants: General above.

4. Remove all roots and substrate above the root collar and the main structural roots according to root correction details so root system conforms to root observations detail.

5. Remove all substrate at the bottom of the root ball that does not contain roots.

6. Using a hose, power washer or air excavation device, wash out the substrate from

around the trunk and top of the remaining root ball and find and remove all stem girdling roots within the root ball above the top of the structural roots.

3.11 GROUND COVER, PERENNIAL AND ANNUAL PLANTS

A. Where ground cover is shown on plans, groundcover planting continues under shrubs and trees at specified spacing. Ground cover shall not be planted in the shrub or tree watering basins per the contract details.

B. Assure that soil moisture is within the required levels prior to planting. Irrigation, if required, shall be applied at least 12 hours prior to planting to avoid planting in muddy soils.

C. Assure that soil grades in the beds are smooth and as shown on the plans.

D. Plants shall be planted in even, triangularly spaced rows, at the intervals called out for on the drawings, unless otherwise noted. The first row of Annual flower plants shall be 6 inches from the bed edge unless otherwise directed.

E. Dig planting holes sufficiently large enough to insert the root system without deforming the roots. Set the top of the root system at the grade of the soil.

F. Schedule the planting to occur prior to application of the mulch. If the bed is already mulched, pull the mulch from around the hole and plant into the soil. Do not plant the root system in the mulch. Pull mulch back so it is not on the root ball surface.

G. Press soil to bring the root system in contact with the soil.

H. Spread any excess soil around in the spaces between plants.

I. Apply mulch to the bed being sure not to cover the tops of the plants with or the tops of the root ball with mulch.

J. Water each planting area as soon as the planting is completed. Apply additional water to keep the soil moisture at the required levels. Do not over water.

3.12 PALM PLANTING

A. Palm trees shall be placed at grade making sure not to plant the tree any deeper in the ground than the palm trees originally stood.

B. The trees shall be placed with their vertical axis in a plumb position.

C. All backfill shall be native soil except in cases where planting in rock. Water-settle the back fill.

D. Do not cover root ball with mulch or topsoil.

E. Provide a watering berm at each palm. Berms shall extend a minimum of 18 inches out from the trunk all around and shall be a minimum of (6) inches high.

F. Remove twine which ties fronds together after placing palm in planting hole and securing it in the upright position.

3.13 STAKING AND GUYING

A. Do not stake or guy trees unless specifically required by the Contract Documents, or in the event that the Contractor feels that staking is the only alternative way to keep particular trees plumb.

1. The Landscape Architect shall have the authority to require that trees are staked or to reject staking as an alternative way to stabilize the tree.
2. Trees that required heavily modified root balls to meet the root quality standards may become unstable. The Landscape Architect may choose to reject these trees rather than utilize staking to temporarily support the tree.

B. Trees that are guyed shall have their guys and stakes removed after one full growing season or at other times as required by the Landscape Architect.

C. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer's recommendations and the planting detail for installation.
1. Plants shall stand plumb after staking or guying.
2. Stakes shall be driven to sufficient depth to hold the tree rigid.

D. For trees planted in planting mix over waterproofed membrane, use dead men buried 24 inches to the top of the dead man, in the soil. Tie the guy to the dead man with a double wrap of line around the dead man followed by a double half hitch. When guys are removed, leave the dead men in place and cut the guy tape 12 inches above the ground, leaving the tape end covered in mulch.

3.14 TREE BARK PROTECTION

A. For all street trees in commercial areas where indicted on the drawings, apply a Tree Bark Protector to each tree.

3.15 STRAIGHTENING PLANTS

A. Maintain all plants in a plumb position throughout the warranty period. Straighten all trees that move out of plumb including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled.

B. Do not straighten plants by pulling the trunk with guys.

3.16 INSTALLATION OF FERTILIZER AND OTHER CHEMICAL ADDITIVES

A. Do not apply any soluble fertilizer to plantings during the first year after transplanting unless soil test determines that fertilizer or other chemical additives is required. Apply chemical additives only upon the approval of the Landscape Architect.

B. Controlled release fertilizers shall be applied according to the manufacturer's instructions and standard horticultural practices.

3.17 PRUNING OF TREES AND SHRUBS

A. Prune plants as directed by the Landscape Architect. Pruning trees shall be limited to addressing structural defects as shown in details; follow recommendations in "Structural Pruning: A Guide For The Green Industry" published by Urban Tree Foundation, Visalia CA.

B. All pruning shall be performed by a person experienced in structural tree pruning.

C. Except for plants specified as multi-stemmed or as otherwise instructed by the Landscape Architect, preserve or create a central leader.

D. Pruning of large trees shall be done using pole pruners or if needed, from a ladder or

hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting. Pruning may also be performed at the nursery prior to shipping.

E. Remove and replace excessively pruned or malformed stock resulting from improper pruning that occurred in the nursery or after.

F. Pruning shall be done with clean, sharp tools.

G. No tree paint or sealants shall be used.

3.18 MULCHING OF PLANTS

A. Apply three inches of mulch before settlement, covering the entire planting bed area. Install no more than 1 inch of mulch over the top of the root balls of all plants. Taper to 2 inches when abutting pavement.

B. For trees planted in lawn areas the mulch shall extend to a 5 foot radius around the tree or to the extent indicated on the plans.

C. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

3.19 PLANTING BED FINISHING

A. After planting, smooth out all grades between plants before mulching.

B. Separate the edges of planting beds and lawn areas with a smooth, formed edge cut into the turf with the bed mulch level slightly lower, 1 and 2 inches, than the adjacent turf sod or as directed by the Landscape Architect. Bed edge lines shall be a depicted on the drawings.

3.20 WATERING

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of Substantial Completion Acceptance. The Contractor shall adjust the automatic irrigation system, if available, and apply additional or adjust for less water using hoses as required.

B. Hand water root balls of all plants to assure that the root balls have moisture above wilt point and below field capacity. Test the moisture content in each root ball and the soil outside the root ball to determine the water content.

3.21 CLEAN-UP

A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
   1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.

B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Landscape Architect’s seals are to remain on the trees and removed at the end of the warranty period.

C. Make all repairs to grades, ruts, and damage by the plant installer to the work or other work at the site.

D. Remove and dispose of all excess planting soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.22 PROTECTION DURING CONSTRUCTION

A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection during installation until Substantial Completion Acceptance. Treat, repair or replace damaged work immediately.

B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Landscape Architect shall determine when such cleaning, replacement or repair is satisfactory.

3.23 PLANT MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION ACCEPTANCE

A. During the project work period and prior to Substantial Completion Acceptance, the Contractor shall maintain all plants.

B. Maintenance during the period prior to Substantial Completion Acceptance shall consist of pruning, watering, cultivating, weeding, mulching, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings reasonably free of damaging insects and disease, and in healthy condition. The threshold for applying insecticides and herbicide shall follow established Integrated Pest Management (IPM) procedures. Mulch areas shall be kept reasonably free of weeds, grass.

3.24 SUBSTANTIAL COMPLETION ACCEPTANCE

A. Upon written notice from the Contractor, the Landscape Architect shall review the work and make a determination if the work is substantially complete.
   1. Notification shall be at least 7 days prior to the date the contractor is requesting the review.

B. The date of substantial completion of the planting shall be the date when the Landscape Architect accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

C. The Plant Warranty period begins at date of written notification of substantial completion from the Landscape Architect. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.

3.25 MAINTENANCE DURING THE WARRANTY PERIOD BY OTHERS

A. After Substantial Completion Acceptance, the Contractor shall make sufficient site visits to observe the Owner’s maintenance and become aware of problems with the maintenance in time to request changes, until the date of End of Warranty Final Acceptance.

1. Notify the Landscape Architect in writing if maintenance, including watering, is not sufficient to maintain plants in a healthy condition. Such notification must be made in a timely period so that the Landscape Architect may take corrective action.
    a. Notification must define the maintenance needs and describe any corrective action required.
2. In the event that the Contractor fails to visit the site and or notify, in writing, the Landscape Architect of maintenance needs, lack of maintenance shall not be used as grounds for voiding or modifying the provisions of the warranty.

3.26 MAINTENANCE DURING THE WARRANTY PERIOD BY THE PLANT INSTALLER

A. During the warranty period, provide all maintenance for all plantings to keep the plants in a healthy state and the planting areas clean and neat.

B. General requirements:
    1. All work shall be undertaken by trained planting crews under the supervision of a foreman with a minimum of 5 years experience supervising commercial plant maintenance crews.
    2. All chemical and fertilizer applications shall be made by licensed applicators for the type of chemicals to be used. All work and chemical use shall comply with all applicable local, provincial and federal requirements.
    3. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures to maintain the site in a safe manner for visitors at all times.
    4. All workers shall wear required safety equipment and apparel appropriate for the tasks being undertaken.
    5. The Contractor shall not store maintenance equipment at the site at times when they are not in use unless authorized in writing by the Landscape Architect.
    6. Maintenance vehicles shall not park on the site including walks and lawn areas at any time without the Landscape Architect’s written permission.
    7. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the Landscape Architect, and submit a copy of the logs at the end of each year of the maintenance agreement.
    8. Meet with the Landscape Architect a minimum of three times a year to review the progress and discuss any changes that are needed in the maintenance program. At the end of the warranty period attend a hand over meeting to formally transfer the responsibilities of maintenance to the Landscape Architect. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs and soil test data. Make the Contractor’s supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.

C. Provide the following maintenance tasks:
    1. Watering; Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
        a. Maintain all watering systems and equipment and keep them operational.

   b. Monitor soil moisture to provide sufficient water. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water.
2. Soil nutrient levels: Take a minimum of 4 soil samples from around the site in the spring and fall and have them tested by an accredited agricultural soil testing lab for chemical composition of plant required nutrients, pH, salt and % organic matter. Test results shall include laboratory recommendations for nutrient applications. Apply fertilizers at rates recommended by the soil test.
   a. Make any other soil test and/or plant tissue test that may be indicated by plant conditions that may not be related to soil nutrient levels such as soil contaminated by other chemicals or lack of chemical uptake by the plant.
3. Plant pruning: Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the Landscape Architect, do not shear plants or make heading cuts.
4. Restore plants: Reset any plants that have settled or are leaning as soon as the condition is noticed.
5. Guying and staking: Maintain plant guys in a taught position. Remove tree guys and staking after the first full growing season unless directed by Landscape Architect.
6. Weed control: Keep all beds free of weeds. Hand-remove all weeds and any plants that do not appear on the planting plan. Chemical weed control is permitted only with the approval of the Landscape Architect. Schedule weeding as needed but not less *12 times per year*.
7. Trash removal: Remove all trash and debris from all planting beds and maintain the beds in a neat and tidy appearance. The number of trash and debris removal visits shall be no less than 12 times per year and may coincide with other maintenance visits.
8. Plant pest control: Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks.
   a. The Landscape Architect must approve in advance the use of all chemical pesticide applications.
9. Plant replacement: Replace all plants that are defective as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.
10. Mulch: Refresh mulch once a year to maintain complete coverage but do not over mulch. At no time shall the overall mulch thickness be greater that three inches. Do not apply mulch within 6 inches of the trunks or stems of any plants. Replacement mulch shall meet the requirements of the original approved material. Mulch shall be no more than one inch on top of the root ball surface.
11. Bed edging: Check and maintain edges between mulch and lawn areas in smooth neat lines as originally shown on the drawings.
12. Leaf, fruit and other plant debris removal: Remove fall leaf, spent flowers, fruit and plant part accumulations from beds and paved surfaces. Maintain all surface water drains free of debris. Debris removal shall be undertaken at each visit to weed or pick up trash in beds.
13. Damage from site use: Repair of damage by site visitors and events, beyond normal

wear, are not part of this maintenance. The Landscape Architect may request that the Contractor repair damage beds or plantings for an additional cost. All additional work shall be approved in advance by the Landscape Architect.

3.27 END OF WARRANTY FINAL ACCEPTANCE / MAINTENANCE OBSERVATION

A. At the end of the Warranty and Maintenance period the Landscape Architect shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory.
   1. If the work is satisfactory, the maintenance period will end on the date of the final observation.
   2. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the Landscape Architect.

B. FAILURE TO PASS OBSERVATION: If the work fails to pass final observation, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Landscape Architect.

END OF SECTION

SECTION 33 11 00 - SITE WATER DISTRIBUTION UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Site water distribution systems located outside the building perimeter, extending to an existing water line or meter.

B. Related Requirements:

1. Division 01 - General Requirements.
2. Division 22 – Plumbing.
3. Section 31 2313 - Excavation and Fill.
4. Section 31 2323 - Excavation and Fill for Utilities.
5. Section 32 0117 - Pavement Repair.
6. Section 32 1313 - Site Concrete Work.
7. Section 33 3000 - Site Sanitary Sewer Utilities.

1.02 SUBMITTALS

A. Shop Drawings: Submit site plan indicating locations of lines, valves, and related appurtenances.

B. Product Data: Manufacturer’s catalog data for materials. Include technical data for accessories, gaskets, joints and couplings.

C. Certificates: Certificates attesting that tests set forth in referenced publications have been performed, and the performance requirements have been satisfied.

1.03 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement:

1. American National Standards Institute (ANSI):
   a. ANSI H23.1 - Seamless Copper Water Tube.
2. NSF International (NSF):
   a. ANSI/NSF 61 Drinking Water System Components – Health Effects.

b. ANSI/NSF 372 Drinking Water System Components – Lead Content.

3. American Society of Mechanical Engineers (ASME):

a. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

b. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

c. ASME B16.26 - Cast Copper Alloy Fitting for Flared Copper Tubes.

d. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings.

4. American Society for Testing and Material (ASTM) International:

a. ASTM A36 – Standard Specification for Carbon Structural Steel.

b. ASTM A240 – Standard Specification for chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

c. ASTM A312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

d. ASTM A536 - Standard Specification for Ductile Iron Castings.

e. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.

f. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

g. ASTM B75 - Standard Specification for Seamless Copper Tube.

h. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

i. ASTM B152 – Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar.

j. ASTM 17 – Standard Specifications for Copper Alloy Sand Castings for General Applications.

k. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

l. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

m. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

n. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

o. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

p. ASTM D3350 - Standard Specification for Polyethylene Plastics and Fittings Materials.

q. ASTM F2620 - Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

r. ASTM F2206 - Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE).

s. ASTM F477 - Standard Specification for Elastomeric Seals for Joining Plastic Pipe.

t. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

5. American Water Works Association (AWWA):

a. AWWA C104/A21.4 - Cement-Mortar Lining For Ductile-Iron Pipe and Fittings.

b. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings

c. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

d. AWWA C115/A21.15 - Standard for Flanged Ductile-Iron Pipe with Threaded Flanges.

e. AWWA C153/A21.53 – American National Standard for Ductile-Iron Compact Fittings for Water Service

f. AWWA C207 – Steel Pipe Flanges for Waterworks Service Sizes 4 In. Through 144 In.

g. AWWA C500 - Metal Seated Gate Valves for Water Supply Service.

h. AWWA C503 - Wet- Barrel Fire Hydrants.

i. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 inches through 24 inches (50-mm through 600-mm) NPS.

j. AWWA C510-89 - Standard for Double Check Valve Backflow-Prevention Assembly.

k. AWWA C511 - Reduced-Pressure Principal Backflow-Prevention Assembly.

l. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

m. AWWA C800 - Underground Service Line valves and Fittings.

n. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 4 In. Through 12 In., for Water Transmission and Distribution.

o. AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. Through 3 In., for Water Service.

p. AWWA M23 - PVC Pipe - Design and Installation.

q. AWWA M55 - PE Pipe - Design and Installation.

6. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:

a. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

7. Uni-Bell PVC Pipe Association (UBPPA):

a. UBPPA UNI-PUB-09 - Installation Guide for Gasketed-Joint PVC Pressure Pipe (C900).

8. Underwriters Laboratories Inc. (UL):

a. UL 246 – Standard for Hydrants for Fire-Protection Service.

b. UL 262 – Standard for Gate Valves for Fire-Protection Service.

c. UL 312 – Standard for Check Valves for Fire-Protection Service.

9. National Pollutant Discharge Eliminations System (NPDES):

a. Comply with storm water requirements of general permit for storm water discharges when flushing pipe systems including storm drains and maintaining logs.

10. Plastic Pipe Institute (PPI):

a. TN-38 – Bolt Torque for Polyethylene Flanged Joints.

b. TR-4 – Technical Report requirements of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipes.

c. TR-33 – Technical Report for Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

B. Provide valves from the same manufacturer.

C. Manufacturer of plumbing products must be third-party certified to ANSI/NSF Standard 61, Section 9 certification, and ANSI/NSF 372 to demonstrate compliance with the federal requirements for lead contribution to drinking water, the Safe Drinking Water Act SDWA, and the California Health and Safety Code Section 116875. No pipe, pipe fitting, or any other fitting or fixture intended to convey or dispose water for human consumption for drinking or cooking is allowed in the domestic plumbing system, if they do not meet the low lead definition of Health and Safety Code 116875. Weighted average lead content of the wetted surface area of pipes, fittings and fixtures may not exceed 0.25 percent.

D. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production as reviewed by the ARCHITECT.

1.04 PRODUCT HANDLING

A. Store items above ground on platforms, skids, or other required supports.

B. Protect materials from direct sunlight.

C. Protect coating and linings on piping, fittings, and accessories from damage. Repair and/or replace damaged coatings or linings.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipes, Fittings, and Joints:

P-3: Underground water service pipe sizes 4-inch and larger shall be C900 water service pipe material complying with AWWA C900, and ASTM D1784 Cell Class 12454B with tracer wire, NSF and UL listed. Piping shall be plain end or gasket bell end, pressure class 305 (DR14) with cast iron pipe equivalent outside diameter.

PF-3: Fire Water Service, Domestic Water and Irrigation Service Line Fittings, Joints and Jointing Materials shall be Ductile-iron with mechanical joints conforming to AWWA C110/A21.10 or AWWA C153/A21.53, C900 compatible, and shall have cement mortar lining conforming to AWWA C104/A21.4, standard thickness unless otherwise indicated on Drawings.

a. Pipe joints shall be push on as specified in ASTM D3139.

b. Joints between pipe and metal fittings, valves, and other accessories shall be mechanical joints as specified in AWWA C111/A21.11.

c. Provide each joint connection with an elastomeric gasket suitable for the bell or coupling installation.

d. Gaskets for push on joints for pipe shall conform to ASTM F477.

e. Gaskets for push on joints and compression type joints or mechanical joints for connections between pipes and metal fittings, valves, and other accessories shall be as specified in AWWA C111/A21.11.

f. Sleeve-type mechanically coupled joints may be provided instead of push-on joints on plain-end PVC plastic joints. Comply with requirements of ASTM D3139.

g. Comply with installation guide UBPPA UNI-PUB-09.

Manufacturer: JM Eagle, Diamond Plastics, North American Pipe, or equal.

P-4: Aboveground water service pipe shall be Type 316L Stainless Steel, Schedule 40 water pipe, marked with manufacturer's identification and fittings. Manufacturer's representative shall instruct installers and certify them for joint installation. Piping system shall be provided with a five-year manufacturer’s material warranty.

Manufacturer: Viega, or equal.

PF-4: Type 316L Stainless Steel, Schedule 40 Press Fittings. For water service piping systems, provide with EPDM seals. Manufacturer's representative shall instruct installers and certify them for joint installation.

Manufacturer: Viega, or equal.

B. Gates Valves for PVC:

1. Non-rising stem type with resilient wedge gates or iron body bronze wedge gates and mechanical joint ends conform to AWWA C500.

2. Non-rising stem type with mechanical joints ends shall conform to AWWA C509.

3. Valves designed for a working pressure of 175 PSI shall be inside-screw type with operating nut, and resilient wedge type gate. Valve shall be provided with mechanical joints as required for the pipe to which it is intended to connect.

4. Valves with UL listing of 262 shall conform to AWWA C500. Valves shall open by counter-clockwise rotation of valve stem.

5. Stuffing boxes shall be provided with O-ring stem seals and shall be bolted and constructed to permit easy removal of parts for repair.

6. Sleeve type mechanical couplings may be provided instead of mechanical and push on joint ends.

7. Valve ends and gaskets for connection to sleeve type mechanical couplings shall conform to specified requirements for the joint or coupling.

C. Gate Valves in Valve Pits:

1. Outside screw and yoke rising stem type valves with resilient wedge gates and flanged ends shall conform to AWWA C500.

2. Outside screw and yoke rising stem type valves with flanged ends shall conform to AWWA C509.

3. Outside screw and yoke type Valves with double disc gates or split-wedge type gate and flanged ended ends shall be designed for 175 psi and conform to UL 262.

4. Provide valves with hand wheels that open by counterclockwise rotation of the valve stem.

5. Stuffing boxes shall be provided with O-ring stem seals and shall be bolted and constructed to permit easy removal of parts for repair.

D. Check Valves for PVC:

1. Valves shall be swing-check type conforming to AWWA C508 or UL 312.

2. Valves shall be provided with cast iron or steel body and cover, flanged ends and clear port opening.

3. Valves shall be designed for a working pressure of 175 PSI.

E. Valve Boxes: 14 ¾-inch by 20-inch by 12-inch cast concrete with cast iron, traffic grade cover marked “WATER” (for use over water valves).

1. Brooks 36-H MB with No. 36-T cast iron cover EISEL 363.5, or equal.

F. Mechanical Thrust Restraint:

1. Restraint shall be incorporated into the follower gland.

2. Restraint shall consist of individually actuated wedges that increase resistance to pull out as internal pressure or external forces increase.

3. Gland shall be ductile iron conforming to ASTM A536.

4. Provide twist off nuts and tee-head bolts of the same size to ensure proper actuating of restraint devices.

5. Restraining device shall be provided with pressure rating equal to that of the pipe on which it is installed.

6. Restraining gland shall be UL listed.

7. Mechanical thrust restraint devices shall be EBAA Iron “Megalug” or equal.

G. Restraint Device Adapters:

1. Restrained flange adapters shall be provided instead of threaded or welded flange spool pieces on plain end of ductile iron or PVC pipe.

2. Flange adapters shall be manufactured of ductile iron conforming to ASTM A536 and be provided with flange bolt circles compatible with AWWA C115/A21.15.

3. Restraint of flange adapter shall consist of a multiple number of individually actuated gripping wedges to maximize restraint capability.

4. Torque limiting actuating screws shall be provided to insure proper initial set of gripping wedges.

5. Flange adapter shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow at least 0.6 inch of gap between end of pipe and mating flange without affecting integrity of seal.

6. Flange adapter shall be provided with a safety factor of at least 2:1 for rated pressure.

7. Restraint device adapters shall be EBAA Iron “Megaflange”, or equal.

H. Tracer Wire for Nonmetallic Pipes: Tracer wires shall be continuous solid copper wire type THWN, 12 AWG gauge, with heat and moisture resistance insulation. Blue plastic covered for domestic water and red for fire sprinkler. (Aluminum wire is prohibited). Provide in sufficient length to be continuous over each installed section of nonmetallic pipe.

I. Pipe markers shall be a concrete plaque inscribed with the word “WATER.”

J. Water Service Line Materials:

1. Water Service Line Piping Material: Refer to article 2.01.A within this section.

2. Water Service Line Appurtenances:

a. Corporation stops shall be ground key type; manufactured of bronze conforming to ASTM B61 or ASTM B62; and suitable for the working pressure of the system. Ends shall be suitable for solder-joint or flared tube compression type joint connection. Threaded ends for inlet and outlet of corporation stops shall conform to AWWA C800; coupling nut for connection to flared copper tubing and shall conform to ASME B16.26.

b. Goosenecks shall be type K copper tubing. Joint ends for goosenecks shall be as required for connecting to corporation stop and service line. Where multiple gooseneck connections are required for individual service, connect goosenecks to service line through brass or bronze branch connection; the total clear area of branches shall be at least equal to clear area of service line. Length of goosenecks shall be as indicated or required.

c. Curb or service stops shall be ground key, round way, inverted key type; bronze, conforming to ASTM B61 or ASTM B62; and rated at 150 psi. Ends shall be as required for connection to service piping. Arrow shall be cast into body of curb or service stop indicating direction of flow.

d. Gate valves 2.5-inch and larger shall be MSS SP-80, Class 150, solid wedge, or resilient wedge gate, and non-rising stem. Valves shall be provided with flanged end connections. Provide hand wheel operators if easily accessible. Provide operating nut if inside a vault, pit or valve box.

e. Gate valves in valve pits 2-inch, and smaller shall be MSS SP-80, Class 150, bronze, solid wedge, inside screw, rising stem. Valves shall be provided with flanged end connections or threaded end connections with union on one side of valve and hand wheel operator.

f. Valve boxes shall be provided at each gate valve installed underground. Valve boxes shall be a size suitable for valve on which it is installed.

K. Water meter will be installed by water purveyor for the area, unless noted otherwise.

L. Strainers:

STR-1 Description: Wye type with Monel or Stainless Steel strainer cylinder (manufacturer's standard mesh), and gasketed machine strainer cap. Where indicated on Drawings, provide with valved (globe valve) blow out piping, same size as blow out plug:

2-inch and smaller: C.M. Bailey #100-A, bronze, 250 pound, or ductile iron with fusion bonded epoxy coating.

2 ½-inch and larger: Watts 77F-DI-FDA-125 pound, or other ductile iron fusion bonded epoxy coated flanged strainer, conforming to ASTM A312 for the strainer body, and ASTM A240 for the stainless steel strainer element. (No iron body strainer shall be used on potable water that is not fusion bonded epoxy coated inside and out.)

C.M.Bailey, Armstrong, Wilkins, Watts, or equal.

STR-2 "Y" pattern, cast iron bodies, 125 psi, Monel screen 16 square. mesh. Open area at least twice the cross-sectional area of IPS pipe in which strainer is installed and may be woven wire or perforated type. Screwed ends for sizes up to 2-inch, flanged ends for 2 ½-inch and larger perforations, in accordance with the following:

Bailey #100, Armstrong, Rp & C , Keckley, or equal.

STR-3 Bucket type, flange, semi-steel body, 125 psi, stainless steel screen with 1/8 inch diameter perforations (mounted above grade for water service). All sizes, for lines serving fire sprinkler risers:

Bailey #1, Zurn 150 Series, Rp 7 C, Watts 97fb-Fsfe, or equal.

STR-42" and larger: Watts 077-F-SS Stainless steel flange type strainer, or equal conforming to ASTM A312 for strainer body, ASTM A240 for the SS strainer element and ASTM A36 for base flange material.

M. Backflow Preventer Assemblies:

1. Assembly shall be provided with flanged connections, ductile iron with fusion bonded epoxy coated construction, bronze, or stainless steel.

2. Backflow preventer shall be suitable for cold water working pressure of 175 psi.

3. Internal parts shall be designed for replacement without removing valves from line.

4. Double check backflow preventer assembly shall consist of two independently acting spring cam or poppet style check valves, 2 shut-off valves and 4 test cocks. Check valve shall be designed to provide drip tight closure against reverse flow, low pressure drop at maximum flow capacity. Spring-loaded checks shall cause valve to seal against a higher inlet pressure than outlet pressure when there is no flow.

5. Double check backflow preventer assembly shall meet AWWA Standard C510-89. Assembly shall be Ames 2000ss, Febco 850, Watts 709, Wilkins 350, or equal.

6. Reduced pressure backflow preventer assembly shall consist of two check valves located between two shut-off valves with an area of reduced pressure between two check valves and a relief device arranged to discharge to atmosphere.

   a. Comply with AWWA Standard C511.

   b. Fluctuation in piping pressure shall not cause cycling. Backflow preventer shall automatically maintain low pressure zone to positively prevent backflow of water into system. Assembly shall automatically indicated failure of any part vital to backflow prevention by the continuous discharge relief device.

   c. Reduced pressure backflow preventer assembly shall be Cla-Val Model RP-4, or equal.

7. Backflow prevention assemblies (devices), shall be tested and certified by a certified backflow tester, and a test report shall be provided to the water agency having jurisdiction. Testing shall be performed in the presence of the Project Inspector.

PART 3 - EXECUTION

3.01 EXCAVATION, BACKFILLING AND COMPACTING

A. Conform to requirements in Section 31 2323 - Excavation and Fill for Utilities or Section 31 2313 - Excavation and Fill.

3.02 PIPE INSTALLATION

A. Project site water lines shall terminate approximately 5 feet from buildings, unless otherwise indicated on Drawings. Temporarily cap or plug terminals for future connection to building.

3.03 CLEARANCES OF WATER LINE

A. Building or Structures: Two feet.

B. Parallel to Sewer Line:

1. Water line 4-inch or less in diameter shall not be installed in a common trench with the building sanitary drain unless the bottom of the water line is at least 12 inches above the top of the building sanitary drain or where the water line is installed on a solid shelf excavated on one side of the common trench with a minimum clear horizontal distance of 12 inches from the building sanitary drain.

2. Water lines 6-inch and larger in diameter shall be separated from the Project site sanitary sewer, receiving more than one building sanitary drain or acid pipeline, in accordance with the requirement of the State of California, Human and Welfare Agency, Department of Health Services.

C. Crossing Sewer Line:

1. A water line shall be separated from sanitary sewer in accordance with the requirements of the State of California Administrative Code, Title 22, Section 64630(e)(2).

2. Install water line a minimum of 12 inches clear, above or below a sanitary sewer.

3. A water line 6-inch or greater in diameter, crossing under a Project site sanitary sewer line, shall be installed with joints located at least 10 feet away from each side of the sanitary sewer line.

4. A water line 6-inch or greater in diameter, crossing over a Project site sanitary sewer line, shall be installed with joints located at least 4 feet away from each side of a purple pipe or sanitary sewer line.

D. Install water lines no closer than 10 feet horizontally clear from the edge of sewage leach fields, seepage pits, and septic tanks.

3.04 PIPE INSTALLATION AND JOINING

A. Install all piping and fitting systems according to the manufacturer requirement.

B. Remove fins and burrs from pipe and fittings.

C. Clean piping, fitting, valves, and accessories before installing. Maintain items in a clean condition.

D. Provide proper facilities for lowering sections of pipe into trenches. Do not drop into piping, fittings, or other materials into trenches. Accurately cut pipe and install without

springing or forcing. Replace any piping or fitting that does not provide sufficient space for proper installation of joining material.

E. Blocking or wedging between bells and spigots is not permitted. Install bell and spigot pipe with bell end pointing in the direction of flow.

F. Install piping to the lines and grades indicated or required. Low points and dips are not permitted. Support piping at proper elevation and grade with secure and uniform supports. Wood support blocking is not permitted. Where sand cement slurry will not be furnished for backfill, install piping so that full length of each section of pipe and each fitting will solidly rest on pipe bedding. Excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where indicated or required for installation. Provide proper allowances and devices for expansion and contraction of piping and systems.

G. Maintain trenches free of standing water until pipe joints have been installed.

H. At the end of each day close open ends of pipe with temporary caps of the same material as the pipe.

I. Do not install piping when trench or weather conditions prevent proper installation.

3.05 INSTALLATION OF TRACER WIRE AND PIPE MARKERS

A. Tracer Wire: Install continuous length of tracer wire for full length of each run of nonmetallic pipe. Fasten wire to top of pipe in such a manner that it will not be displaced during construction operations. Wire shall be fastened to pipe at not greater than 20-foot intervals. Wire shall terminate above finished grade with a 12-inch lead taped around each riser. Provide a tracer wire to grade under a permanent marker where straight-line transitions of metallic to non-metallic pipe are installed.

B. Underground Pipe Markers: Provide markers at grade where non-metallic pipe is installed and for each horizontal change in direction.

3.06 CONNECTIONS TO EXISTING WATER LINES

A. After Project Inspector has inspected installation, perform connections to servicing water lines. Schedule service shutdown for connecting new system at a time causing minimum disruption.

3.07 INSTALLATION OF C900 PLASTIC WATER SERVICE LINE

A. Unless otherwise indicated, install pipe and fittings as specified and in accordance with UBPPA UNI-B-09 and AWWA M23, Chapter 7, “Installation”.

B. Jointing:

1. Provide push on joints with elastomeric gaskets specified for this type of joint, furnishing either elastomeric-gasket bell-end pipe or elastomeric-gasket

couplings. For pipe-to-pipe push on joint connections, provide pipe with push on joint ends furnished with factory installed bevel; for push on joint connections to metal fittings, valves and other accessories, square cut spigot end off pipe end.

2. Provide push on joint lubricant recommended by manufacturer.

3. Install push on joints for pipe-to-pipe connections in accordance with UBPPA UNI-PUB-09 and AWWA M23, Chapter 7, "Installation."

4. Install push on joints for connection to fittings, valves, and other accessories in accordance with requirements of UBPPA UNI-PUB-09 and with applicable requirements of AWWA C600.

5. Compression-type joints/mechanical-joints with gaskets, glands, bolts, nuts and internal stiffeners shall be installed in accordance with the requirements of UBPPA UNI-PUB-09 and AWWA C600 and Appendix A to AWWA C 111/A21.11.

   a. Square cut spigot off end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel.

6. Sleeve-type mechanical couplings shall be provided in strict accordance with coupling manufacturer’s recommendations using internal stiffeners as specified for compression-type joints.

C. Provide mechanical thrust restraint devices for anchorage and piping unless thrust blocks are indicated on the Drawings. Thrust blocks shall be installed in accordance with the requirements of UBPPA UNI-PUB-09 except that size and location of blocks shall be as indicated. Thrust blocks shall be provided as specified in Section 32 1313 - Site Concrete Work.

3.08 INSTALLATION OF VALVES

B. Provide gate valves conforming to AWWA C500 and UL 262 in accordance with AWWA C600 for valve and fitting installation and with recommendations of AWWA C500 Appendix “Installation, Operation, and Maintenance of Gate Valves”.

C. Provide gate valves conforming to AWWA C600 in accordance with AWWA C509 for valve and fitting installation and with recommendations of AWWA C500 Appendix “Installation, Operation, and Maintenance of Gate Valves”.

D. Provide gate valves on PVC water service lines in accordance with AWWA M23 Chapter 7, “Installation.”

E. Provide check valves and fittings in accordance with applicable requirements of AWWA C600 unless noted otherwise on the Drawings.

F. Provide gate and check valve joints as specified for the type of joints between pipe and fittings.

3.09 INSTALLATION OF BACKFLOW PREVENTERS

A. Install reduced pressure backflow preventers to comply with RULE 16D of LADWP in the jurisdictional boundaries of Los Angeles Department of Water and Power.

3.10 INSTALLATION OF STRAINERS:

A. Strainers shall be installed on each water line downstream of the meter, above grade at the pressure regulating station. When a pressure regulating station (assembly) is not provided, “wye” type flange strainer shall be provided, with a shut off valve on the inlet and the outlet side.

B. If the water line is serving fire sprinkler risers or hydrants, then an approved fire service strainer shall be used: Watts 97DB-FSFE, or equal.

3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. For complete requirement and procedure refer to section 22 1000, article 3.12.

3.12 ELECTROLYSIS PREVENTION

A. A minimum 6-inch long brass nipple shall be installed at locations specified or as required. Flanges shall be provided with a complete insulating component consisting of; gasket bolt sleeves and bolt washers. Dielectric insulators shall be installed at locations indicated or as required. Dielectric fittings are prohibited.

B. Where steel or cast iron below grade connects to copper or brass piping above grade, the transition from steel or cast iron pipe to copper or brass pipe shall be installed in an above grade accessible location.

C. Underground connections between dissimilar metals shall be in accessible yard boxes.

D. Above ground dielectric connections shall be exposed.

3.13 ABANDONING WATER LINES AND STRUCTURES

A. Water lines and appurtenances to be abandoned in place shall be cut and removed from areas where new Work is being installed.

B. Cap or plug abandoned existing drain lines below grade in a yard box and according to CBC.

3.14 TESTS AND INSPECTIONS

A. Provide labor, equipment, materials, test equipment and incidentals required for performing required field tests.

B. Tests shall not be performed for five days after concrete thrust blocks have been installed.

C. Testing Procedure: Water service lines shall be tested in accordance with applicable specified standard.

1. Test water service lines in accordance with applicable requirements of AWWA C600. No leakage is permitted.

2. Pressure testing: Before pressure test, fill portion of piping being tested with water for a minimum of 24 hours. Provide hydrostatic pressure of at least 50 psi greater than the maximum working pressure of tested system, but no less than 200 psi hydrostatic test pressure for system piping of 2-inch in diameter and larger. Provide and maintain hydrostatic test pressure for at least two hours to ensure no leakage of any portion of piping or appurtenances under pressure test.

3.15 CLEANING

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

3.16 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION

SECTION 33 30 00 - SITE SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Building Sanitary Sewer Lateral.

2. Closed-circuit television inspection of sewer laterals.

B. Related Requirements:

1. Division 01 - General Requirements.

2. Division 22 – Plumbing.

3. Division 23 - Mechanical.

4. Section 31 2313 - Excavation and Fill.

5. Section 31 2323 - Excavation and Fill for Utilities.

6. Section 32 0117 - Pavement Repair.

7. Section 32 1313 - Site Concrete Work.

1.02 SUBMITTALS

A. Shop Drawings: Submit site plan denoting locations of lines, valves, and appurtenances.

B. Product Data: Manufacturer’s catalog data for materials. Include technical data for accessories, gaskets, joints and couplings.

C. Certificates: Certificates attesting that tests set forth in referenced publication have been performed and the results required by design have been met.

D. Closeout Submittal: Submit three DVD’s of Closed-circuit television inspections performed. Include the following information:

1. Electronic Media Recordings: Visual and audio record of the entire length of pipe. For existing laterals identify problem areas, such as roots, cracks, fractures, broken pipe, and other unusual conditions found.

2. Digital Photographs of the pipe condition, connections, points of interest and defects found. Indicate distance of defects to a point of reference such as face of building or mainline.

3. Inspection Log: Provide written report including:

   a. Date and time of inspection.

   b. Name of School, Project, CONTRACTOR, and operator name.

   c. Location, material and size of pipe.

   d. Description of defects found.

1.03 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement:

   1. Standard Specifications for Public Works construction, current edition.

   2. California Plumbing Code, CPC, current edition.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Pipeline: Building or Project Site Sanitary Sewer and Vent: Minimum 5 feet away from building boundaries. For piping within 5 feet from building boundaries, and interior piping refer to Division 22 plumbing sections.

   1. Cast iron soil pipe: Hubless, service weight, ASTM A888, CISPI 301, conforming to CISPI 310 and installed in accordance to IAPMO IS 6. Manufacturer: American Foundry, Tyler, or AB&I, or equal.

      a. Cast iron soil coupling: Hubless, heavy-duty with neoprene gaskets, stainless steel corrugated shields, and 4 bands of stainless-steel clamps. IAPMO, ASTM C564 and CISPI 310. Manufacturer: American Foundry, Mission Rubber Company, Tyler, or equal.

   2. Vitrified clay extra strength piping with plain ends. Comply with ASTM C700. Install with mechanical compression couplings. Joints shall comply with ASTM C425. Installation shall be in accordance with ASTM C12.

      Manufacturer: Mission Clay Products, or equal.

   3. Acid waste and vent pipeline from building to Sampling Box: Refer to Division 22 for corrosive waste and vent piping.

B. Cleanout Assemblies: Cleanout plug shall be line size.

   1. In covered concrete-paved floors: Iron body with UPC recognized plug, top, and adjustable sleeve, cut-off ferrule, polished brass/nickel/bronze, and secured Scoriated cover:

a. Square:

J.R.SMITH	ZURN	JOSAM	OR EQUAL
4053	Z1400-SZ	57008-Z-1-SQ	

b. Round:

J.R.SMITH	ZURN	WADE	JOSAM	OR EQUAL
4033	Z1400-BZ	W-6000	57008-Z-1	

2. Outside covered concrete-paved floors: Secured cover, extra heavy-duty, adjustable sleeve, cut-off ferrule, UPC recognized brass type plug, scoriated tractor type cover:

J.R.SMITH	ZURN	OR EQUAL
4233	Z1402-HD	

3. In yard boxes: Raised threaded head brass plug and Cast Iron Body Cleanout.

J.R.SMITH	ZURN	WADE	JOSAM	OR EQUAL
		8590A		

C. Yard Boxes: 14 1/2-inch by 19 3/4-inch by 12-inch, cast concrete, with cast-iron hinged locking traffic cover with the word “SEWER,” embossed on the cover in one inch high upper case lettering.

BROOKS No. 36-HFL Assembly with cast iron hinged locking cover	OR EQUAL

D. Concrete, Mortar and Related Materials: Conform to Section 32 1313 - Site Concrete Work, unless noted otherwise.

E. Metal Covers, Frames and Accessories:

1. Conform to Section 206 – Miscellaneous Metal Items of the Standard Specifications for Public Works Construction.

2. Metal Covers and Frames: Vandal-resistant design and construction.

3. Hot-dip galvanize steel parts after fabrication and prior to assembly in accordance with Section 210 – Paint and Protective Coating of the Standard Specifications for Public Works Construction.

F. Bedding Materials: Conform to the requirements of Section 31 2313 - Excavation and Fill or Section 31 2323 - Excavation and Fill for Utilities, as required.

PART 3 – EXECUTION

3.01 SANITARY SEWER INSTALLATION

A. Install sanitary sewers in a uniform alignment and slope to the point of connection as indicated. Before trench excavation, verify size, material, depth, and location of the point of connection. Minimum depth of below grade sewer lines shall be 24 inches to centerline of pipe

B. Pipe slope shall not be less than ¼ inch per foot or 2 percent unless pipe inverts are indicated. Where invert elevations are indicated, install pipe at a uniform slope between inverts.

C. Join pipes and fittings as recommended by the manufacturer.

3.02 CLEARANCE OF SANITARY SEWERS

A. Buildings or Structures: Two feet.

B. Parallel to Water Line:

1. Building sanitary drain, is not permitted to be installed in a common trench with a potable water line unless the bottom of the water line is at least 12 inches above the top of the sanitary sewer.

2. In addition, the potable water line shall be installed on a solid shelf excavated on one side of the common trench with a minimum clear horizontal distance of 12 inches from the sanitary sewer or building sanitary drain.

3. Project site sanitary sewer, receiving more than one building sanitary drain or acid pipeline, shall be separated from a potable water line in accordance with the requirements of the California Health, and Human Services Agency: Department of Public Health.

4. Any new or existing domestic water line, reclaimed water line, and/or irrigation line shall have a minimum 10 feet clear horizontal distance from the new or existing onsite sanitary sewer lines.

C. Crossing Water Line:

1. Building sanitary drain shall be installed a minimum of 12 inches below the potable water line.

2. Project site sanitary sewer shall be separated from the potable water main in accordance with the requirements of the State of California Administrative Code, Title 22, Section 64630(e)(2).

3.03 MANHOLES

A. Provide manholes in accordance with the Standard Plans for Public Works Construction, unless otherwise indicated.

B. Adjust manholes in accordance with the sub-section 302-5.8 Manholes (and other structures) of the Standard Specifications for Public Works Construction.

3.04 CLEANOUTS

A. Provide cleanout at the upper terminal for each sanitary pipeline, at intervals not exceeding 100 feet in straight run and any fraction thereof and for each aggregate horizontal change in direction exceeding 135 degrees.

B. Install required cleanouts before back filling of horizontal pipelines.

C. In unpaved and asphalt-paved areas, install cleanouts in yard boxes 2 inches below the yard box cover.

D. In concrete-paved areas, extend cleanouts flush with finish grade.

E. In traffic areas, install countersunk cleanout plugs where raised heads protrude.

3.05 ABANDONED SEWERS AND STRUCTURES

A. Plug or cap every abandoned sanitary sewer within 5 feet of the property line in a code required manner.

B. Demolish abandoned sanitary structures such as cesspool, septic tank, sewage pit, and manholes to a minimum depth of 5 feet below the finish grade, including removal of sewage. Disconnect any piping. After inspection, completely fill with earth, sand, gravel, cement-sand slurry, or other required material.

3.06 TESTING

A. After installation, test each sanitary drain and/or sewer and each section between successive manholes for either infiltration or exfiltration. Test shall be conducted in accordance with Section 306 - Underground Conduit Construction of the Standard Specifications for Public Works Construction.

B. Where excessive ground water is encountered test the pipeline for infiltration.

C. When infiltration or exfiltration exceeds allowable amounts as set forth in the Section 306 formula, perform repairs or replacements as necessary to comply with the required limits.

3.07 CLOSED-CIRCUIT TELEVISION INSPECTION

A. Coordinate with OAR time and date of inspection. Project Inspector shall be present during the CCTV inspection.

B. Clean laterals by hydraulic jet.

C. Perform internal closed-circuit television inspection of lateral from the building to the public mainline. Record sewer in its entirety with no breaks or interruptions. Move camera at a speed no greater than 30 feet per minute, stopping for a minimum of ten seconds to record pipe connections, defects, and points of interest.

D. Maintain technical quality, sharp focus and distortion free picture. Pan, tilt, and rotate as necessary to best view and evaluate connections, defects and points of interest.

E. Closed-circuit Television Equipment: As a minimum equipment shall include:

1. Television camera specially designed for pipe inspections, and operative in 100 percent humidity conditions.

2. Camera and television monitor capable of producing minimum 470H-line resolution color video picture.

3. Camera capable to inspect laterals as small as three inches up to 70 feet from sewer mainline.

4. Camera lighting shall be suitable to allow clear picture of inner wall at least ten feet in front.

F. Defective Work:

1. New Laterals: Defective Work found shall be repaired at CONTRACTOR’s expense. Perform a new closed-circuit television inspection at no cost to OWNER.

2. Existing Laterals:

a. If roots, sludge, or sediment material or other defect not related to the Work of this project impedes inspection, withdraw camera, restart inspection from opposite end and notify OAR of defects found.

b. If obstruction or stoppage was caused by Work related to this project, remove obstruction at no cost to OWNER. Perform a new closed-circuit television inspection at CONTRACTOR’s expense.

3.08 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.09 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION

SECTION 33 40 00 - STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes storm drainage piping; sub-surface drains; metal covers, grates and frames; catch basins; box culverts; manholes, and BMPs.

1. Best Management Practices (BMPs):

a. Catch Basin Inserts.

b. Downspout Filters.

c. Stormwater Planter

2. Closed-circuit television inspection of storm drain lines.

1.02 RELATED REQUIREMENTS

A. Division 01 - General Requirements.

B. Section 01 7416 - Storm Water Pollution Prevention Plan.

C. Section 01 7417 – BMP Implementation Plan.

D. Section 01 7418 – Water Pollution Control.

E. Section 22 1000 - Plumbing.

F. Section 31 2313 - Excavation and Fill.

G. Section 31 2323 - Excavation and Fill for Utilities.

H. Section 32 0117 - Pavement Repair.

I. Section 32 1313 - Site Concrete Work.

1.03 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.

B. ASME: American Society of Mechanical Engineers.

C. ASTM: American Society for Testing and Materials.

D. BMP: Stormwater Best Management Practice.

E. CBC: California Building Code.

F. CCTV: Closed-Circuit Television.

G. DET: Detention BMP.

H. DWV: Drain, Waste, and Vent.

I. FILT: Filter BMP.

J. GS: Gravity Separator.

K. HDPE: High Density Polyethylene.

L. IAPMO: International Association of Plumbing and Mechanical Officials.

M. IOR: Inspector of Record.

N. NPS: Nominal Pipe Size.

O. OAR: OWNER's Authorized Representative.

P. PE: Polyethylene.

Q. Post Construction BMP: Devices installed by the CONTRACTOR for storm water management to be left on site after construction completion.

R. PP: Polypropylene.

S. PVC: Poly Vinyl Chloride.

T. RET: Retention.

U. SDR: Standard Dimensions Ratio.

V. VEG: Vegetative.

W. OWNER: El Monte Union High School District

X. SWPPP: Storm Water Pollution Prevention Plan.

1.04 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):

1. ASHTO M 252: Geotextile Specification for Highway Applications.

2. AASHTO M 294: Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.

3. AASHTO M 330: Standard Specification for Polypropylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.

B. American Society for Testing and Materials International (ASTM):

1. ASTM A888: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

2. ASTM C14: Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.

3. ASTM C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

4. ASTM C564: Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

5. ASTM C76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

6. ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

7. ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures.

8. ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures.

9. ASTM D2564: Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

10. ASTM D2665: Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

11. ASTM D2855: Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

12. ASTM D3034: Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

13. ASTM D3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

14. ASTM D448: Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

15. ASTM F1866: Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings.

16. ASTM F2306: Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

17. ASTM F2418: Standard Specification for Polypropylene Corrugated Wall Stormwater Collection Chambers.

18. ASTM F2764: Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.

19. ASTM F2787: Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers.

20. ASTM F2881: Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications.

21. ASTM F2922: Standard Specification for Polyethylene Corrugated Wall Stormwater Collection Chambers.

22. ASTM F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

23. ASTM F656: Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

24. ASTM F794: Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

C. Cast Iron Soil Pipe Institute (CISPI):

1. CISPI 301: Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

2. CISPI 310: Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

D. The International Association of Plumbing and Mechanical Officials (IAPMO):

1. IAPMO IS 6: Hubless Cast Iron Sanitary and Rainwater Systems - Installation Standards.

E. Standard Specifications for Public Works Constructions (Greenbook):

1. Section 202: Masonry Materials.

2. Section 206: Miscellaneous Metal Items.

3. Section 207: Pipe.

4. Section 208: Pipe Joint Types and Materials.

5. Section 210: Paint and Protective Coatings.

6. Section 306: Underground Conduit Construction.

1.05 SUBMITTALS

A. Shop Drawings: Submit site plan denoting locations of lines, valves, and appurtenances.

B. Product Data: Manufacturer's catalog data for all required materials. Include technical data for accessories, information concerning gaskets, joints and couplings.

C. Certificates: Certificates attesting that tests set forth in referenced publication have been performed and the results required by design have been met.

D. Closeout Documents: At Substantial Completion submit to the OAR two CD's and one hard copy of the documents indicated in paragraphs 1 through 5 below:

1. Maintenance Log: Provide Microsoft Excel Spreadsheet including the following information:

a. Maintenance log and upkeep records of the installed Post Construction BMPs. Include the following headers as a minimum: "Date of Service", "Location of BMP", "Type of Maintenance or Service", "Notes", "Next Scheduled Preventive Maintenance Due", and "Inspector Signature".

b. Maintenance Requirements: Include the following headers as a minimum: "BMP Description", "Location of BMP and Map Grid Location" and "Type of Maintenance or Service Needed", i.e.; weekly, monthly, quarterly, etcetera. "Stock No.", "Manufacturer Contact Information", along with "Frequency" namely: weekly, monthly, quarterly, etcetera and "Special Instructions".

2. Maintenance Manuals: Provide Maintenance Manual for storm drainage BMP components installed along with requirements, replacement or maintenance schedule and plans with the location of each BMP component. This manual shall include product information cut sheet, shop drawings, vendor information for each component and warranty.

3. Record drawings: 'As-Builts' site plan(s) showing Post Construction BMP. Provide a copy of marked record set with red pencil identifying any variations from design documents.

4. Training Documentation:

   a. OWNER attendees sign off training sheet.

   b. Two DVD's of materials covered in the training and components installed.

5. Post-Construction BMP Maintenance Plan: Submit complete Plan per Attachment "A", edit per As-Built conditions and provide missing information.

6. Records of Closed-Circuit Television Inspection: At Substantial Completion submit to the OAR three DVD's of Closed-circuit television inspections performed. Include the following information:

   a. Electronic Media Recordings: Visual and audio record of the entire length of pipe. For existing laterals identify problem areas, such as roots, cracks, fractures, broken pipe, and other unusual conditions found.

   b. Digital Photographs of the pipe condition, connections, points of interest and defects found. Indicate distance of defects to a point of reference such as face of building or mainline. Provide the Digital Photographs after fixing the defective pipes.

   c. Inspection Log: Provide written report including:

      1. Date and time of inspection.

      2. Name of School, Project, CONTRACTOR, and operator name.

      3. Location, material and size of pipe.

      4. Description of defects found and attempts to fix them.

1.06 QUALITY ASSURANCE

A. Comply with the following as a minimum requirement: Standard Specifications for Public Works Construction, current edition.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic products, pipes, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle all products according to manufacturer's written rigging instructions.

1.08 TRAINING OF OWNER PERSONNEL

A. At Substantial Completion and when the storm drainage system is fully operational, knowledgeable representatives from the CONTRACTOR and manufacturer(s) of the components specified and installed at the site shall provide up to 8 hours of training. Date, time and location for the training shall be coordinated through the project OAR. Have OWNER attendees sign off training sheet and provide a copy to the OAR.

B. Training period shall cover but not be limited to the following:

1. Explain the operation of storm drainage system and its design intent.

2. Explain the maintenance requirements of every component of the system.

3. Provide recommendations of practices to minimize or eliminate negative impact on the system.

4. Provide maintenance schedule as recommended by the manufacturers for every component and review it with OWNER's Maintenance and Operations staff.

5. Conduct a site walk, identify every component of the system and demonstrate its operation.

6. Training shall be conducted with the use of Maintenance log and Maintenance manual.

1.09 SURPLUS MATERIALS

A. Provide enough additional materials for each component of BMP that requires replacement or service during the first year.

PART 2 – MATERIALS AND PRODUCTS

2.01 PIPING MATERIALS

A. General: Minimum 5 feet away from building boundaries. For piping within 5 feet from building boundaries, and interior piping refer to Division 22 plumbing sections. Provide piping system in conformance with Section 207 - Pipe and Section 208 - Pipe Joint Types and Materials of the Standard Specifications for Public Works Construction. All Soil-tight pipes shall be provided with joints that are function of opening size, channel length, and backfill particle size. A backfill material containing a high percentage of fine-graded soils requires investigation for the specific type of joint to be used to guard against soil infiltration, including the requirement for fabric-wrapped joints.

B. Nonreinforced Concrete Pipe (CP): ASTM C14, with bell-and-spigot ends and gasketed joints with ASTM C443 rubber gaskets.

C. PVC (Poly Vinyl Chloride) Schedule 40 DWV Pipe:

1. Conform to ASTM D2665, ASTM F794, and ASTM F1866.

2. Installer of PVC Schedule 40 DWV piping system shall carry ASTM D2855 and ASME B31.3 qualification. Installer shall provide proof of these qualifications to IOR prior to commencing work.

3. Containers for solvent and primer shall be clearly marked with manufacturer's data. Solvent and primer shall not be more than one year old. The safety placards must be visible.

4. Blue or red-hot glue shall not be used.

5. Approved manufacturers and products:

a. Pipe: Charlotte pipe and foundry, Harvel Plastics Inc., JM Eagle, Spears Manufacturing Company, or equal.

b. Primer: Weld-On P-70 by IPS, Conforming to ASTM F656.

c. Cement: Weld-On 711 (gray) by IPS, Conforming to ASTM D2564.

D. PVC (Poly Vinyl Chloride) SDR-35 Pipe, 6” through 15”:

1. Conform to ASTM D3034.

2. Gasketed Joints: Elastomeric gasket joints conforming to ASTM D3212.

3. Gaskets: Chloroprene conforming to ASTM F477.

4. Approved manufacturers: Charlotte pipe and foundry, Harvel Plastics Inc., JM Eagle, Spears Manufacturing Company, or equal.

1.02 BEDDING MATERIAL FOR PIPE

A. General: Conform to the requirements of Section 31 2313 - Excavation and Fill or Section 31 2323 - Excavation and Fill for Utilities, as required.

B. Approved manufacturers and products:

1. Propex Fabrics, Inc.: Geotex 451.

2. TenCate Geosynthetics Americas: Mirafi 140N.

3. US Fabrics, Inc.: 120NW.

4. Equal products.

1.03 PERFORATED SUBSURFACE DRAIN PIPE

A. Shop-perforated with perforations symmetrically located within a maximum arc of 160 degrees. Perforations shall provide a total open area of at least 0.3 square inches per linear foot of pipe, with a minimum of one perforation per linear foot, except for joint areas. Perforation shall be either holes or slots. Hole diameters of ¼ inch minimum to 3/8 inch maximum. Width of slots of 3/16 inch minimum to 5/16 inch maximum with slot length not exceeding 4 inches.

B. Aggregate Around Perforated Pipe shall be 6 inches of gravel containing no particles finer than a 3/8-inch to 1/2-inch sieve opening size.

1.04 STORMWATER TREATMENT SYSTEMS /BMPS

A. GS-2: Catch Basin Inserts, approved manufacturers and products:

1. AbTech Industries: UUF DI-DO.

2. ADS-FlexStorm: FlexStorm Pure or Catch-it.

3. Aquashield Inc.: Aqua-Guardian.

4. Ecosense International: EcoSense International’s Catch Basin Insert.

5. Oldcastle Precast Inc.: FLoGard, or GISB.

6. UltraTech International Inc.: Ultra-Drain Guard.

7. Equal products.

B. GS-3: Downspout Filters, approved manufacturers and products:

1. Oldcastle Precast Inc.: FLoGard +Plus.

2. Equal products.

C. VEG-2: Stormwater Planter

D. VEG-4: Vegetated Swales

1.05 MISCELLANEOUS MATERIALS

A. Metal Covers, Grates, Frames and Accessories:

1. Conform to Section 206 - Miscellaneous Metal Items of the Standard Specifications for Public Works Construction.

2. Hot-dip galvanize steel parts after fabrication in accordance with Section 210 - Paint and Protective Coatings of the Standard Specifications for Public Works Construction.

3. Grates and Frames:

a. Vandal-proof design and construction.

b. ADA compliant, in conformance to CBC 11B-302.3.

c. Rated for vehicular traffic on areas intended for use by motor vehicles.

d. Hot-dip galvanized.

B. Concrete, Mortar and Related Materials: Conform to Section 32 1313 - Site Concrete Work.

C. Manhole Brick Mortar, Grout, and Plaster: Conform to Standard Specifications for Public Works Construction, Section 202 - Masonry Materials.

D. Underground Concrete Structures: Shall be precast and rated for H-20 traffic loading and applicable soil loads. The materials and structural design of the devices shall be per ASTM C857 and ASTM C858.

1.06 NAMEPLATES

A. Stainless steel or aluminium nameplate permanently fastened to BMP showing the following information:

1. BMP ID number and BMP type.

2. Next service day followed by a 1-inch by 4-inch long blank space.

3. Manufacturer name, model number, telephone number and stock ID number.

4. Installation or production date.

5. 1-inch by 4-inch blank space for OWNER’s use.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. CONTRACTOR shall arrange for a preconstruction meeting with the manufacturer’s representative to review the basic principles for proper installation of Underground BMP type products prior to any installation.

B. Underground Concrete modules shall be installed in accordance with manufacturer's instructions and the current ASTM C891 procedures.

3.02 EXCAVATION, BACKFILLING AND COMPACTING

A. Conform to the requirements of Section 31 2313 - Excavation and Fill or Section 31 2323 - Excavation and Fill for Utilities, as required.

3.03 INSTALLATION OF PIPE

A. Conform to Section 306 - Underground Conduit Construction of the Standard Specifications for Public Works Construction.

B. Non-ferrous drainpipe installed with less than 12 inches of cover to finish grade shall be provided with a 4-inch thick concrete pipe encasement.

3.04 DRAINAGE APPURTENANCES

A. Catch basins, junction chambers, manholes, box culverts, outlet chambers and other drainage structures: Construct as indicated on Drawings and as specified in Section 32 1313 - Site Concrete Work, and in compliance with the Standard Specifications for Public Works Construction, Section 303 - Concrete and Masonry Construction.

B. Ensure that Post Construction BMP have a visible identifying manufacturer tag with product identification, manufacturer contact information, date of last service and date of next service due.

C. Provide storm drain stencil per City or County requirements as applicable.

3.05 STORMWATER TREATMENT SYSTEMS/BMPs

A. VEG-2: Stormwater Planter

1. Design storm rainfall depth: 85th Percentile

2. Planting mix: uniform mix of sand and organic material, minimum 24 inches soil depth.

3. Design Percolation rate: minimum infiltration rate of 12 inches per hour.

4. Ponding depth: maximum 12 inches. Includes 3 inches mulch well-aged, shredded or chipped woody debris or plant material.

5. Time to fill maximum ponding: 3 hours.

6. Provide splash block for downspout and inlet pipes.

7. Install waterproofing on inside surface area of the planter wall.

8. Install 1 foot gravel bed reservoir course washed gravel; approximately ¾" in diameter at the bottom with optional 3" of Choker ¼"- ½" washed P gravel.

9. Install non-woven geotextile filter fabric between soil planting mix and gravel bed.

10. Install longitudinal 6 inches diameter perforated pipe (PVC SDR 26 or PVC C9000) wrapped in non–woven geotextile membrane with gravel envelope of at least 3 feet wide and 6 inches deep. Underdrain minimum slope: 0.5%.

11. Install 6 inches diameter PVC (SDR 26) overflow pipe with atrium grate inlet at 12 inches above finish grade.

12. Provide non-perforate outflow pipe connected to storm drain line. Minimum 0.5% slope.

13. Typical 1 inch chamfer on planter wall edges.

14. Maximum height of stormwater planter box: 51 inches.

15. Minimum width of stormwater planter box: 30 inches.

16. Refer to Los Angeles County Low Impact Development Standards Manual for information not provided on this section.

B. VEG-4: Vegetated Swales

1. Design storm rainfall depth: 85th Percentile

2. Vegetated side slopes at 2H:1V maximum slope.

3. Install 1 foot gravel bed reservoir course washed gravel; approximately ¾" in diameter at the bottom.

4. Install 2 feet planting media with minimum infiltration rate of 5 in/hr.

5. Install non-woven geotextile filter fabric between soil planting mix and gravel bed.

6. Install longitudinal 6 inches diameter perforated pipe (PVC SDR 26 or PVC C9000) wrapped in non–woven geotextile membrane with gravel envelope of at least 3 feet wide and 6 inches deep. Underdrain minimum slope: 0.5%

7. Install 12 inches diameter PVC (SDR 26) overflow pipe with atrium grate inlet at 12 inches above finish grade.

8. Provide non-perforate outflow pipe connected to storm drain line. Minimum 0.5% slope.

9. Provide splash block for downspout and inlet pipes.

10. Install 45-mil impermeable liner: firestone pond line or equal wrapping the swales bottom and side surface to prevent infiltration of water to natural soil.

11. Refer to Civil Detail and Los Angeles County Low Impact Development Standards Manual for information not provided on this section.

3.06 ABANDONED DRAINAGE LINES AND STRUCTURES

A. Cap or plug existing drain lines that are cut and abandoned and remove existing drainage structures that are abandoned.

3.07 CLOSED-CIRCUIT TELEVISION INSPECTION

A. Coordinate with OAR time and date of inspection. Project Inspector shall be present during the CCTV inspection.

B. Clean laterals by hydraulic jet.

C. Perform internal closed-circuit television inspection of lateral from the building to the public mainline. Record drain line in its entirety with no breaks or interruptions. Move camera at a speed no greater than 30 feet per minute, stopping for a minimum of ten seconds to record pipe connections, defects, and points of interest.

D. Maintain technical quality, sharp focus and distortion free picture. Pan, tilt, and rotate as necessary to best view and evaluate connections, defects and points of interest.

E. Minimum Requirements for Closed-circuit Television Equipment:

1. Television camera specially designed for pipe inspections, and operative in 100 percent humidity conditions.

2. Camera and television monitor capable of producing minimum 470H-line resolution color video picture.

3. Camera capable to inspect lines as small as three inches up to 70 feet from storm drain mainline.

4. Camera lighting shall be suitable to allow clear picture of inner wall at least ten feet in front.

F. Defective Work:

1. New Lines: Defective Work found shall be repaired at CONTRACTOR’s expense. Perform a new closed-circuit television inspection at no cost to OWNER.

2. Existing Laterals:

a. If roots, sludge, or sediment material or other defect not related to the Work of this project impedes inspection, withdraw camera, restart inspection from opposite end and notify OAR of defects found.

b. If obstruction or stoppage was caused by Work related to this project, remove obstruction at no cost to OWNER. Perform a new closed-circuit television inspection at CONTRACTOR's expense.

3.08 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

B. Maintain Post Construction BMP after installation and keep a maintenance log to be turned over to OAR at Substantial Completion.

3.09 PROTECTION

A. Protect the Work of this section until Substantial Completion.

END OF SECTION