

**Cal Poly University
San Luis Obispo**

TECH PARK PHASE 2
Construction Documents
EDA Award No. 07-79-07500

19-6 Architects Project No. 21179.01

April 2023

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SECTION 01 11 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK INCLUDED IN THE CONTRACT

- A. Work Included in the Contract: All construction and services required for the construction of a new multi story, research and development facility. Partially occupied and partially warm shell space of approximately ~~30,000~~ ^{16,250} sf floor area, including:
 - 1. Site preparation.
 - 2. Site utilities.
 - 3. Site paving.
 - 4. Landscape irrigation system and landscape planting.
 - 5. Site fencing and site appurtenances.
 - 6. New building per the criteria documents.
 - 7. Plumbing and heating, ventilating and air conditioning systems.
 - 8. Wet-pipe fire suppression (sprinkler) system, to be provided on a design/build basis, to suit the requirements of the facility and conforming applicable Codes, ordinances and standards of authorities having jurisdiction.
 - a. Private fire service main shall be provided as indicated on Civil Drawings.
 - b. Details of connections to private fire service main shall be included according to approved design/build wet-pipe fire suppression system.
 - 9. Electrical power, lighting and signal systems.
 - 10. Coordination of work being performed by others under separate contracts with University, described in Article below titled "CONCURRENT WORK UNDER SEPARATE CONTRACTS."
 - 11. Additional general information concerning the Project is provided on the Architectural Drawings.

1.3 CONCURRENT WORK UNDER SEPARATE CONTRACTS

- A. Work Under Separate Contracts: University may award separate design and construction contracts concurrent with this Contract and in the future, as determined by the University, for work listed below and for other work as University may determine. Such work under separate contracts may be indicated on the Drawings and in the Specifications as "Not in Contract", "NIC", "Future" or "Under Separate Contract".
 - 1. Furniture both interior and exterior
 - 2. Emergency generator
 - 3. Refer to the Criteria set of documents for further descriptions.
- B. Relationship to Work Under the Contract: Work under the Contract shall include all provisions necessary to make such concurrent work under separate contracts complete in every respect and fully functional, including field finishing. Provide necessary backing, supports, piping, conduit, conductors and other such provisions from point of service to

point of connection, as shown on Drawings and specified herein. See [Section 01 31 00 - Project Management and Coordination](#) for additional requirements.

- C. Documents for Work Under Separate Contracts: University's Representative will make available, in a timely manner, drawings and specifications of work under separate contracts for coordination and further description of that work.
 - 1. If available, such information will include drawings, specifications, product data, lists and construction schedules for such work.
 - 2. Information concerning work under separate contracts or directly by University will be provided for convenience only and shall not to be considered Contract Documents.
- D. Permits, Notices and Fees for Work under Separate Contracts: Notices required by and approvals required of, authorities having jurisdiction over work under separate contracts and related fees, will be solely the responsibility of University.

1.4 PROTECT THE WORK FROM VANDALISM

- A. During Work Hours. Protect the Work from theft, vandalism, and unauthorized entry. The Contractor shall have the sole responsibility for job site security. Refer to Specification 01 54 01 – SECURITY for additional information
- B. During Off-Work Hours. During all hours that Work is not being prosecuted and at the Contractor's discretion, furnish such watchman's services as Contractor may consider necessary to safeguard materials and equipment in storage on the Project site, including Work in place and in process of fabrication, against theft, acts of malicious mischief, vandalism, and other losses or damages.

1.5 OWNER-FURNISHED/CONTRACTOR-INSTALLED PRODUCTS

- A. Owner-Furnished/Contractor-Installed (OFCl) Products: University will furnish, for installation by Contractor, products which are identified on the Drawings and in the Specifications as "OFCl (Owner-Furnished/Contractor-Installed)", "installed by General Contractor," or similar terminology. See Drawings for identification of such products. Refer to Section 01 64 00 - Owner-Furnished Products.
- B. Relationship to Work under the Contract: Work under the Contract shall include all provisions necessary to fully incorporate such products into the Work, including, as necessary, fasteners, backing, supports, piping, conduit, conductors and other such provisions from point of service to point of connection, and field finishing, as shown on Drawings and specified herein. See Section 01 64 00 - Owner-Furnished Products for additional requirements.

1.6 PERMITS, LICENSES AND FEES

- A. Permits, Licenses and Fees, General: Refer to Contract General Conditions, Article 4.11.
- B. Licenses: Contractor shall obtain and pay all licenses associated with construction activities, such as business licenses, contractors' licenses and vehicle and equipment licenses. All costs for licenses shall be included in the Contract Amount.

- C. Parking Fees: Contractor shall obtain and pay for all parking permits and fees for all vehicles parked on University property. Refer to Section 01 55 00, Vehicular Access and Parking for additional parking requirements.

1.7 PARTNERING

- A. The Trustees intend to encourage the foundation of a cohesive partnership with the Contractor and its Subcontractors, the Architect and its consultants, and the Trustees. This partnership will be structured to draw on the strengths of each organization to identify and achieve reciprocal goals. The objectives are effective and efficient Contractor performance, intended to achieve completion within budget, on schedule, and in accordance with the Contract Drawings and Specifications.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION 01 11 00

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SECTION 01 14 00 - WORK RESTRICTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 CONTRACTOR'S USE OF PREMISES AND SITE, GENERAL

- A. Contractor's Use of Premises and Site, General: Refer to Contract General Conditions
 1. Contractor shall at all times perform Work so as to impose no hardship on the Trustees or others engaged in the Trustees' work nor cause unreasonable delays or hindrance thereto.
 2. Construction activities shall be scheduled to minimize disruption to the University and to Campus users.
 3. Contractor may not interrupt any Campus utilities without prior written permission from the Trustees.
 4. Contractor shall leave the site clean and neat each day. See 01 74 00 CLEANING REQUIREMENTS for additional information.

1.3 USE OF PREMISES

- A. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
 1. Limits: Confine constructions operations to Project Area indicated on the Drawings. Use of other areas shall be only with the approval of University's Representative.
 2. University Occupancy: Where existing buildings and site areas are indicated for continued use by University, make provisions to continued use by scheduling and sequencing of Work under the Contract. Make provisions for temporary barriers, enclosures, covers, directional signage and other construction facilities and temporary controls to enable continuing use.

1.4 CONTRACTOR'S USE OF PROJECT AREA

- A. Location of Work: The Work shall be accomplished within areas indicated on Drawings as Project Area or, if not indicated, to areas as directed by University's Representative. Use of other areas, including parking areas, shall be subject to approval by University's Representative. Refer to Section 01 52 05 - Construction Staging Areas and Section 01 55 00 - Vehicular Access and Parking for additional requirements.
 1. Contractor shall not unreasonably encumber the site with materials or equipment.
 2. Contractor shall assume full responsibility for protection and safekeeping of products stored on the premises.
 3. Contractor shall move any stored products which interfere with operations of University or contractors performing work under separate contracts for

- University.
4. Temporary closures or restrictions of use of public thoroughfares, necessary to accomplish the Work, shall be made only as approved in advance by public safety and parking authorities having jurisdiction, as directed in writing by the University's Representative.
 5. Additional off-site laydown, staging or parking area may be available for Contractor use. If available, the area may be rented from the University for a fee and shall not be back charged to the University. Contractor shall coordinate with the University's Representative if additional off site space is needed.
- B. Contractor's Use of the Project Area: Unless otherwise specified or indicated on the Drawings, during the construction period the Contractor shall have full use of the designated Project Area for construction operations, including use of the site. Contractor's use of Project Area shall be limited only by University's right to perform construction operations with its own forces or to employ separate contractors on portions of the Project in accordance with the Contract General Conditions.
- C. Protection of Existing Improvements and Facilities: Contractor shall protect property adjacent to the Project Area and all existing improvements and facilities within the Project Area, including paving and landscaping indicated to remain.
1. All existing improvements and facilities, except those specifically indicated for removal or reconstruction, shall be protected with temporary barriers, enclosures and passageways. Refer to additional requirements specified in Section 01 56 00 - Temporary Barriers and Enclosures.
 2. After completion of Work, existing improvements and facilities shall be restored to original condition and location. Project Area shall be cleaned and restored to presentable condition, equivalent to or better than the condition prior to start of Work.
 3. Should existing improvements and facilities be damaged or soiled beyond renovation or repair, new products shall be provided by Contractor equivalent to existing products, as directed by University's Representative.
- D. Project Area Access: Limit access to the site to routes and access points as indicated. If routes and access points are not indicated, access shall be as approved and as directed by University's Representative. Do not restrict access to adjacent facilities and do not restrict access for those performing work under separate contracts for University.
1. Access to and egress from Project Area shall be in strict conformance to prearranged routes approved by University's Representative, with the understanding that curtailment of construction traffic or revision of access routes may be required on short notice if University's operations mandate such changes because of excessive noise or problems of safety, service or supply.
 2. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to service and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances. Deliveries shall be restricted to certain times through each work day. Refer to section 1.5 below.

- b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- E. Emergency Access: Provide pathways, drives, gates, directional signage and other provisions as required by authorities having jurisdiction for emergency access to Project Area and adjoining campus facilities.
- F. Emergency Egress: Maintain all pathways, drives, gates, and other means of egress during construction as required by public safety authorities having jurisdiction.

1.5 TIME RESTRICTIONS

- A. Contractor's Work Hours: Work shall be limited to Monday through Friday, except University-observed holidays and periods when classes are not in session, during hours of 7:00am to 5:00pm.
 - 1. Work on other days and at other hours shall be permitted only with written approval of University's Representative.
 - 2. Prior to start of construction: Obtain a calendar from the Trustees indicating major campus events, study and examination periods, holidays and quarter breaks.
 - 3. Work during final exam periods at ends of class sessions shall be restricted to minimize noise, vibrations and other distracting and inhibiting activities.
 - 4. The Contractor may be asked to suspend work during the following or similar University events:

Commencement: (NO WORK)	Generally the third Saturday in June Generally the third Saturday in December
Open House: (NO deliveries allowed)	Generally the third Friday and Saturday in April
Residence Hall Move-in: (NO Deliveries allowed)	Generally weekend before Fall Quarter
Finals Weeks: (noise restrictions in place)	Generally the third week in March The week before June commencement The week before December commencement

- 5. If it becomes necessary to perform Work on weekends and holidays, in order to meet milestone and final completion dates, Work shall be performed at no change in Contract Amount unless authorized by written Change Order or Field Instruction.
- B. Utility Outages and Shutdown: Schedule utility outages and shutdowns to nights, weekends, school holidays or times and dates acceptable to and approved by University's Representative.
 - 1. Time and duration of outages and shutdowns shall not hinder normal campus activities except as authorized in writing by University's Representative.
 - 2. Provide seven (7) calendar days notice in writing to University's Representative of

all utility outages and shutdowns. Describe Work to be performed, which utilities will be interrupted and time and duration of interruption.

3. Contractor shall provide temporary utilities to occupied facilities and adjacent properties when utilities must be interrupted for more than two hours, unless otherwise directed by University's Representative.

1.6 NOISE AND VIBRATION RESTRICTIONS

- A. Noise Restrictions: These requirements are in addition to Article 35.03 of the Contract General Conditions. Minimize noise from construction activities.
 1. Maximum noise levels within 1,000 feet of classroom, laboratory, residence, business, adjacent buildings, or other populated area for:
 - a. Trenchers, pavers, graders and trucks: 90 dBA maximum at 50 feet as measured under the noisiest operating conditions.
 - b. Other equipment: 85 dBA at 50 feet as measured under the noisiest operating conditions.
 2. Equipment:
 - a. Jackhammers: Equip with exhaust mufflers and steel muffling sleeves.
 - b. Air compressors: Quiet type such as a "whisperized" compressor. Keep hoods closed while equipment is in operation.
 - c. Portable Noise barriers: Provide around jack hammering or similar construction; 3/4-inch plywood lined with 1-inch thick fiberglass on the work side at a sufficient height and width to reduce noise to acceptable limits.
 3. Operations:
 - a. Keep noisy equipment as far as possible from noise-sensitive site boundaries.
 - b. Do not leave machines idling.
 - c. Use electric power in lieu of internal combustion engine power wherever possible.
 - d. Maintain equipment properly to reduce noise from excessive vibration, faulty mufflers, or other sources.
 - e. Engines shall have properly functioning mufflers.
 4. Scheduling:
 - a. Schedule noisy operations to minimize their duration, and disruption to the adjoining users.
 - b. Notify the Trustees Representative of seven (7) calendar days minimum in advance of performing work creating unusual noise.
 - c. Schedule work at mutually agreeable times.
 5. Do not play radios, tape recorders, televisions, and similar items at construction site.
 6. When work occurs in or near occupied buildings, keep noise associated with construction activities to a minimum. Noisy operations that may disrupt academic or residential activities shall be scheduled after normal work hours.
 7. Trustees reserve the right to stop construction work, including but not limited to noisy work, during the following events: Commencement, Open House, Finals Week, residence hall move-in, Week-of-Welcome, or at other times that may be identified by the Trustees. Trustees reserve the right to stop noisy work when

said work disrupts classes or residential areas. Refer to Section 01 11 00 - Summary of Work.

- B. Vibration Restrictions: Do not perform activities that cause vibrations in adjacent occupied spaces, including spaces above and below location where Work is performed. If vibrations transmit through structure, perform Work at times when University activities are not being conducted. Work may proceed with written authorization from University representative.

1.7 UNIVERSITY RESTRICTIONS

- A. Grand Avenue, Perimeter Road, Highland Drive, or California Boulevard: No large or slow-moving vehicles between the hours of 7:30 a.m. and 8:30 a.m., Monday through Friday, when school is in session.
 - a. Clearance is restricted to 12 feet-6 inches under train bridge on Highland Drive.
 - b. Construction Traffic is restricted to exit campus on Highland Dr. only.
- B. The use of the surrounding residential streets for any contractor use is not allowed.
 - a. Observe all traffic laws on and off campus at all times.
- C. Temporary traffic control and temporary traffic signs:
 - a. Submit all traffic impairment plans to the University for review 2 weeks prior to scheduled traffic impairment. Follow Caltrans guidelines and regulations.
 - b. Large equipment working in and around pedestrian areas shall require a spotter when backing up. Back up beepers are not sufficient.
 - c. Drivers of the equipment or back-up alarms are not considered "spotters."
 - d. Large equipment includes, but is not limited to, backhoes, dump trucks, concrete trucks and delivery trucks.
 - e. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
 - f. Flares and Lights: Use flares and/or lights during hours of low visibility to delineate traffic lanes and to guide traffic.

1.8 UNIVERSITY'S USE OF SITE AND PREMISES

- A. University's Use of Site and Premises: University reserves the right to occupy and to place and install equipment in completed or partially completed areas of buildings and site. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
 - 1. Full University Occupancy: University will occupy site [*and existing building*] during entire construction period. Cooperate with University during construction operations to minimize conflicts and facilitate University usage. Perform the Work so as not to interfere with University's operations.
 - 2. Partial University Occupancy: University reserves the right to occupy and to place and install equipment in completed areas of building provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.
 - 3. Before partial University occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. Unless otherwise agreed, University will provide operation and maintenance of mechanical and electrical systems in portions of the building used

by University. Unless otherwise agreed in writing by the University, warranty periods shall not begin until date established by Notice of Completion filed at Contract closeout.

4. Upon occupancy, University will assume responsibility for maintenance and custodial service for occupied portions of building.

PART 2 - PRODUCTS

Not Applicable to this Section

PART 3 - EXECUTION

Not Applicable to this Section

END OF SECTION 01 14 00

SECTION 01 15 01 - CONSTRUCTION AND DEMOLITION MATERIALS RECYCLING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes: Requirements and procedures for ensuring optimal diversion of construction and demolition (C&D) waste materials generated by the Work from landfill disposal within the limits of the Construction Schedule and Contract Sum.
1. California State law (Assembly Bill 75), requires the California State University to develop source reduction, re-use, recycling, and composting programs, to reduce the tonnage of solid waste disposed in landfills 50% by the year 2004. Construction waste materials generated by the Work are targeted to achieve these diversion rates.
 2. The Work of this Contract requires that a minimum of 85% by weight of the construction and demolition materials generated in the Work is diverted from landfill disposal through a combination of re-use and recycling activities.
 3. For LEED® projects, requirements for submittal of LEED documentation in compliance with Materials and Resources Credit 2.1 and Materials or Resources Credit 2.2, Construction Waste Management.
 3. Requirements for submittal of Contractor's Construction Waste and Recycling Plan prior to the commencement of the Work.
 4. Contractor's quantitative reports for construction waste materials as a condition of approval of the third progress payment. For contracts of shorter duration, this requirement will be enforced as determined by University Representative.

1.2 DEFINITIONS

- A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial, and industrial waste, resulting from construction, remodeling, repair, and demolition operations. A Class III landfill must have a solid waste facilities permit from the California Integrated Waste Management Board (CIWMB) and is regulated by the Enforcement Agency (EA).
- B. Construction and Demolition Debris: Building materials and solid waste resulting from construction, remodeling, repair, cleanup, or demolition operations that are not hazardous as defined in California Code of Regulations, Title 22, Section 66261.3 et seq. This term includes, but is not limited to, asphalt concrete, Portland cement concrete, brick, lumber, gypsum wallboard, cardboard and other associated packaging, roofing material, ceramic tile, carpeting, plastic pipe, and steel. The debris may be commingled with rock, soil, tree stumps, and other vegetative matter resulting from land clearing and landscaping for construction or land development projects.
- C. C&D Recycling Center. A facility that receives only C&D material that has been separated for reuse prior to receipt, in which the residual (disposed) amount of waste in the material is less than 10% of the amount separated for reuse by weight.

- D. Disposal. Final deposition of construction and demolition or inert debris into land, including stockpiling onto land of construction and demolition debris that has not been sorted for further processing or resale, if such stockpiling is for a period of time greater than 30 days; and construction and demolition debris that has been sorted for further processing or resale, if such stockpiling is for a period of time greater than one year, or stockpiling onto land of inert debris that is for a period of time greater than one year.
- E. Enforcement Agency. Enforcement agency as defined [i.e. in Public Resources Code 40130].
- F. Inert Disposal Facility or Inert Waste Landfill: A disposal facility that accepts only inert waste such as soil and rock, fully cured asphalt paving, uncontaminated concrete (including fiberglass or steel reinforcing rods embedded in the concrete), brick, glass, and ceramics, for land disposal.
- G. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.
- H. Mixed Debris Recycling Facility: A processing facility that accepts loads of commingled construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing the non-recyclable residual materials.
- I. Recycling: The process of sorting, cleansing, treating and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.
- J. Reuse. The use, in the same or similar form as it was produced, of a material which might otherwise be discarded.
- K. Separated for Reuse. Materials, including commingled recyclables, that have been separated or kept separate from the solid waste stream for the purpose of additional sorting or processing those materials for reuse or recycling in order to return them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace, and includes materials that have been "source separated."
- L. Solid Waste: All putrescible and nonputrescible solid, semisolid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, dewatered, treated, or chemically fixed sewage sludge which is not hazardous waste, manure, vegetable or animal solid and semisolid wastes, and other discarded solid and semisolid wastes. "Solid waste" does not include hazardous waste, radioactive waste, or medical waste as defined or regulated by State law.
- M. Source-Separated: Materials, including commingled recyclables, that have been separated or kept separate from the solid waste stream at the point of generation for the purpose of additional sorting or processing of those materials for reuse or recycling in order to return them to the economic mainstream in the form of raw materials for

new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace.

- N. Waste Hauler: A company that possesses a valid permit from the local waste management authority to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal in the locality.

1.3 SUBMITTALS

- A. Contractor's Construction Waste and Recycling Plan
1. Review Contract Documents and estimate the types and quantities of materials under the Work that are anticipated to be feasible for on-site processing, source separation for re-use or recycling. Indicate the procedures that will be implemented in this program to effect jobsite source separation, such as, identifying a convenient location where dumpsters would be located, putting signage to identify materials to be placed in dumpsters, etc.
 2. Prior to commencing the Work and within ten (10) calendar days from the date of the Notice to Proceed, submit Contractor's Construction Waste and Recycling Plan. Submit in format provided (Section 01 15 01A). The Plan must include, but is not limited to the following:
 - a. Contractor's name and project identification information;
 - b. Procedures to be used;
 - c. Materials to be re-used and recycled;
 - d. Estimated quantities of materials;
 - e. Names and locations of re-use and recycling facilities/sites;
 - f. Tonnage calculations that demonstrate that Contractor will re-use and recycle a minimum 85% by weight of the construction waste materials generated in the Work.
 3. Contractor's Construction Waste and Recycling Plan must be approved by the Construction Administrator prior to the start of Work.
 4. Contractor's Construction Waste and Recycling Plan will not otherwise relieve the Contractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures.
- B. Contractor's Reuse, Recycling, and Disposal Report
Submit Contractor's Reuse, Recycling, and Disposal Report on the form provided (Section 01 15 01B) with each application for progress payment. Failure to submit the form and its supporting documentation will render the application for progress payment incomplete and delay progress payments. If applicable, include manifests, weight tickets, receipts, and invoices specifically identifying the Project for re-used and recycled materials:
1. Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick).

2. Salvaging building materials or salvage items at an off-site salvage or reuse center (i.e. lighting, fixtures).
3. Recycling source separated materials on site (i.e. crushing asphalt/ concrete for base course, or grinding for mulch).
4. Recycling source separated material at an off-site recycling center (i.e. scrap metal or green materials).
5. Use of material as Alternative Daily Cover (ADC) at landfills.
6. Delivery of soils or mixed inerts to an inertia landfill for disposal (inert fill).
7. Disposal at a landfill or transfer station (where no recycling takes place).
8. Other (describe).

Contractor's Reuse, Recycling, and Disposal Report must quantify all materials generated in the Work, disposed in [Class III] landfills, or diverted from disposal through recycling. Indicate zero (0) if there is no quantity to report for a type of material.

As indicated on the form:

1. Report disposal or recycling either in tons or in cubic yards: if scales are available at disposal or recycling facility, report in tons; otherwise, report in cubic yards. Report in units for salvage items when no tonnage or cubic yard measurement is feasible.
2. Indicate locations to which materials are delivered for reuse, salvage, recycling, accepted as daily cover, inert backfill, or disposal in landfills or transfer stations.
3. Provide legible copies of weigh tickets, receipts, or invoices that specifically identify the project generating the material. Said documents must be from recyclers and/or disposal site operators that can legally accept the materials for the purpose of re-use, recycling, or disposal.

Indicate project title, project number, progress payment number, name of the company completing the Contractor's Report and compiling backup documentation, the printed name, signature, and daytime phone number of the person completing the form, the beginning and ending dates of the period covered on the Contractor's Report, and the date that the Contractor's Report is completed.

- C. For LEED Projects, LEED Letter Template: Materials and Resources Credit [2.1 or 2.2] Construction Waste Management

Complete and sign LEED Letter Template in format provided under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. Prepare Letter Template on company letterhead.

1. Certify that the project has completed a waste management plan and diverted construction, demolition, and land clearing waste to uses other than landfill.
2. Provide quantities of diverted materials and means of diversion in the table provided in the LEED Letter Template.
3. Indicate how and where waste was diverted.
4. Indicate quantities of waste diverted in tons [or cubic yards].
5. Letter Template will calculate: Total quantity of diverted waste, total quantity of waste, and the percentage of waste diverted.

6. For projects where 50% of waste is diverted, one LEED credit will be achieved; where 75% is diverted, two LEED credits will be achieved.
7. Include name, organization, role in project, provide signature and date completed.

PART 2 PRODUCTS

2.1 GUIDE TO LOCAL COMPANIES

- A. Guide to construction and demolition recycling and disposal - the following list is not an exhaustive list and it is the contractors responsibility to verify the information:

CONSTRUCTION AND DEMOLITION RECYCLING GUIDE

			Cardboard	Drywall	Plastic	Asphalt Roofing	Scrap Metals	Wood & Pallets	Green Waste	Scrap Metals	Concrete &
RECYCLING COMPANIES THAT ACCEPT C & D MATERIALS											
A-1 Metals & Salvage	238-3545	Paso Robles					●				
Bedford Metals	922-4977	Santa Maria	●				●				
Heilman Salvage	466-4893	Atascadero					●				
Paso Robles Recycling	238-4678	Paso Robles	●		●						
Zanker Landfill	408/ 263-2384	Gilroy		●		●					

CONSTRUCTION AND DEMOLITION RECYCLING GUIDE

			Cardboard	Drywall	Plastic	Asphalt Roofing	Scrap Metals	Wood & Pallets	Green Waste	Scrap Metals	Concrete &
ROLL-OFF COMPANIES											
★ Note: These companies accept mixed boxes for recycling											
American Equip Svc.	489-9521	Arroyo Grande	●				●	●			
API Roll-Off Services★	928-8689	Santa Maria	●				●	●			
Coastal Roll-Off★	543-0473	San Luis Obispo	●				●	●			
Have Bins	466-3636	Atascadero	●				●	●			
Mid-State Solid Waste	434-9112	Templeton	●				●	●			
Paso Robles Roll-off	238-2385	Paso Robles	●				●	●			
R & R Roll-Off★	929-8000 528-8440	Nipomo	●				●	●			
San Miguel Roll-Off	239-1266	San Miguel	●				●	●			
LAND FILLS & TRANSFER STATIONS											
Chicago Grade Landfill	466-2985	Templeton	●				●	●	●	●	●
Cold Canyon Landfill	549-8332	San Luis Obispo	●				●	●			
Paso Robles Landfill	238-2028	Paso Robles	●				●	●			
Nipomo Transfer Station	922-9255	Nipomo	●				●	●			

PART 3 EXECUTION

3.1 SALVAGE, RE-USE, RECYCLING AND PROCEDURES

- A. Identify re-use, salvage, and recycling facilities.
- B. Develop and implement procedures to re-use, salvage, and recycle new construction and excavation materials, based on the Contract Documents, the Contractor's

Construction Waste and Recycling Plan, estimated quantities of available materials, and availability of recycling facilities. Procedures may include on-site recycling, source separated recycling, and/or mixed debris recycling efforts.

1. Identify materials that are feasible for salvage, determine requirements for site storage, and transportation of materials to a salvage facility.
2. Source separate new construction, excavation and demolition materials including, but not limited to the following types:
 - f. Asphalt.
 - g. Concrete, concrete block, slump stone (decorative concrete block), and rocks.
 - c. Drywall.
 - d. Green materials (i.e. tree trimmings and land clearing debris).
 - e. Metal (ferrous and non-ferrous).
 - f. Miscellaneous Construction Debris.
 - g. Paper or cardboard.
 - h. Red Clay Brick.
 - i. Reuse or Salvage Materials
 - j. Soils.
 - k. Wire and Cable.
 - l. Wood.
 - m. Other (describe)
3. Miscellaneous Construction Debris: Develop and implement a program to transport loads of mixed (commingled) new construction materials that cannot be feasibly source separated to a mixed materials recycling facility.

3.2 DISPOSAL OPERATIONS AND WASTE HAULING

- A. Legally transport and dispose of materials that cannot be delivered to a source separated or mixed recycling facility to a transfer station or disposal facility that can legally accept the materials for the purpose of disposal.
- B. Use a permitted waste hauler or Contractor's trucking services and personnel. To confirm valid permitted status of waste haulers, contact the local solid waste authority.
- C. Become familiar with the conditions for acceptance of new construction, excavation and demolition materials at recycling facilities, prior to delivering materials.
- D. Deliver to facilities that can legally accept new construction, excavation and demolition materials for purpose of re-use, recycling, composting, or disposal.
- E. Do not burn, bury or otherwise dispose of waste on the project job-site.

3.3 RE-USE AND DONATION OPTIONS

- A. Implement a re-use program to the greatest extent feasible. Options may include:

1. California Materials Exchange (CAL-MAX) Program is sponsored by the California Integrated Waste Management Board. CAL-MAX is a free service provided by the California Integrated Waste Management Board, designed to help businesses find markets for materials that traditionally would be discarded. The premise of the CAL-MAX Program is that material discarded by one business may be a resource for another business. To obtain a current Materials Listings Catalog, call CAL-MAX/California Integrated Waste Management Board at (916) 255-2369 or send a FAX to (916) 255-2200. The CALMAX Catalog is available through the Internet Site at <http://www.ciwmb/ca.gov/calmax>.

3.4 REVENUE

- A. Revenues or other savings obtained from recycled, re-used, or salvaged materials shall accrue to Contractor unless otherwise noted in the Contract Documents.

END OF SECTION

SECTION 01 15 01A
CONTRACTOR'S CONSTRUCTION WASTE AND RECYCLING PLAN

(Submit After Award of Contract and Prior to Start of Work)

Project Title:		
Contract or Work Order No.:		
Contractor's Name:		
Street Address:		
City:	State:	Zip:
Phone: ()	Fax: ()	
E-Mail Address:		
Prepared by: (Print Name)		

Date Submitted:		
Project Period:	From:	TO:

Reuse, Recycling or Disposal Processes To Be Used

Describe the types of recycling processes or disposal activities that will be used for material generated in the project. Indicate the type of process or activity by number, types of materials, and estimated quantities that will be recycled or disposed in the sections below:

- 01 - Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick)
- 02 - Salvaging building materials or salvage items at an off site salvage or re-use center (i.e. lighting, fixtures)
- 03 - Recycling source separated materials on site (i.e. crushing asphalt/concrete for reuse or grinding for mulch)
- 04 - Recycling source separated materials at an off site recycling center (i.e. scrap metal or green mats)
- 05 - Recycling commingled loads of C&D mats at an off site mixed debris recycling center or transfer station
- 06 - Recycling material as Alternative Daily Cover at landfills
- 07 - Delivery of soils or mixed inerts to an inert landfill for disposal (inert fill).
- 08 - Disposal at a landfill or transfer station.
- 09 - Other (please describe)

Types of Material To Be Generated

Use these codes to indicate the types of material that will be generated on the project

- | | | | | |
|---|---------------------|------------------|--------------------------|----------------|
| A = Asphalt | C = Concrete | M = Metals | I = Mixed Inert | G = Green Mats |
| D = Drywall | P/C=Paper/Cardboard | W/C = Wire/Cable | S= Soils (Non Hazardous) | |
| M/C = Miscellaneous Construction Debris | R = Reuse/Salvage | W = Wood | O = Other (describe) | |

Facilities Used: Provide Name of Facility and Location (City)

Total Truck Loads: Provide Number of Trucks Hauled from Site During Reporting Period

Total Quantities: If scales are available at sites, report in tons. If not, quantify by cubic yards. For salvage/reuse items, quantify by estimated weight (or units).

SECTION I - RE-USED/RECYCLED MATERIALS

Include all recycling activities for source separated or mixed material recycling centers where recycling will occur.

Type of Material	Type of Activity	Facility to be Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) M	04	ABC Metals, Los Angeles	24	355		
a. Total Diversion			-	-	-	-

SECTION 011511A
 CONTRACTOR'S CONSTRUCTION WASTE AND RECYCLING PLAN
 Continued

SECTION II - DISPOSED MATERIALS						
<i>Include all disposal activities for landfills, transfer stations, or inert landfills where no recycling will occur.</i>						
Type of Material	Type of Activity	Facility to be Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) D	08	DEF Landfill, Los Angeles	2	35		
b. Total Disposal				-	-	-

SECTION III - TOTAL MATERIALS GENERATED						
<i>This section calculates the total materials to be generated during the project period (Reuse/Recycle + Disposal = Generation)</i>						
				Tons	Cubic YD	Other Wt.
a. Total Reused/Recycled				-	-	-
b. Total Disposed				-	-	-
c. Total Generated				-	-	-

SECTION IV - CONTRACTOR'S LANDFILL DIVERSION RATE CALCULATION						
<i>Add totals from Section I + Section II</i>						
		Tons	Cubic Yards	Other Wt.		
a. Materials Re-Used and Recycled		-				
b. Materials Disposed		-				
c. Total Materials Generated (a. + b. = c.)		-	-	-		
d. Landfill Diversion Rate (Tons Only)*		#DIV/0!				

* Use tons only to calculate recycling percentages: $Tons\ Reused/Recycled/Tons\ Generated = \% \text{ Recycled}$

Contractor's Comments (Provide any additional information pertinent to planned reuse, recycling, or disposal activities):

Notes:

- Section 01 15 01A is a Division 01 General Requirement.
- Suggested Conversion Factors: From Cubic Yards to Tons (Use when scales are not available)
 - Asphalt: .61 (ex. 1000 CY Asphalt = 610 tons. Applies to broken chunks of asphalt)
 - Concrete: .93 (ex. 1000 CY Concrete = 930 tons. Applies to broken chunks of concrete)
 - Ferrous Metals: .22 (ex. 1000 CY Ferrous Metal = 220 tons)
 - Non-Ferrous Metals: .10 (ex. 1000 CY Non-Ferrous Metals = 100 tons)
 - Drywall Scrap: .20
 - Wood Scrap: .16

SECTION 01 15 01B
CONTRACTOR'S REUSE, RECYCLING, AND DISPOSAL REPORT

(Submit With Each Progress Payment)

Project Title:		
Contract or Work Order No.:		
Contractor's Name:		
Street Address:		
City:	State:	Zip:
Phone: ()	Fax: ()	
E-Mail Address:		
Prepared by: (Print Name)		

Date Submitted:		
Period Covered:	From:	To:

Reuse, Recycling or Disposal Processes Used

Describe the types of recycling processes or disposal activities used for material generated in the project. Indicate the type of process or activity by number, types of materials, and quantities that were recycled or disposed in the sections below:

- 01 - Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick)
- 02 - Salvaging building materials or salvage items at an off site salvage or re-use center (i.e. lighting, fixtures)
- 03 - Recycling source separated materials on site (i.e. crushing asphalt/concrete for reuse or grinding for mulch)
- 04 - Recycling source separated materials at an off site recycling center (i.e. scrap metal or green mats)
- 05 - Recycling commingled loads of C&D mats at an off site mixed debris recycling center or transfer station
- 06 - Recycling material as Alternative Daily Cover at landfills
- 07 - Delivery of soils or mixed inerts to an inert landfill for disposal (inert fill).
- 08 - Disposal at a landfill or transfer station.
- 09 - Other (please describe)

Types of Material Generated

Use these codes to indicate the types of material that were generated on the project

- | | | | | |
|---|---------------------|------------------|--------------------------|----------------|
| A = Asphalt | C = Concrete | M = Metals | I = Mixed Inert | G = Green Mats |
| D = Drywall | P/C=Paper/Cardboard | W/C = Wire/Cable | S= Soils (Non Hazardous) | |
| M/C = Miscellaneous Construction Debris | R = Reuse/Salvage | W = Wood | O = Other (describe) | |

Facilities Used: Provide Name of Facility and Location (City)

Total Truck Loads: Provide Number of Trucks Hauled from Site During Reporting Period

Total Quantities: If scales are available at sites, report in tons. If not, quantify by cubic yards. For salvage/reuse items, quantify by estimated weight (or units).

SECTION I - RE-USED/RECYCLED MATERIALS

Include all recycling activities for source separated or mixed material recycling centers where recycling occurred.

Type of Material	Type of Activity	Facilities Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) M	04	ABC Metals, Los Angeles	24	355		
a. Total Diversion			-	-	-	-

SECTION 011511B
 CONTRACTOR'S REUSE, RECYCLING, AND DISPOSAL REPORT
 Continued

SECTION II - DISPOSED MATERIALS						
<i>Include all disposal activities for landfills, transfer stations, or inert landfills where no recycling occurred.</i>						
Type of Material	Type of Activity	Facilities Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) D	08	DEF Landfill, Los Angeles	2	35		
b. Total Disposal				-	-	-

SECTION III - TOTAL MATERIALS GENERATED						
<i>This section calculates the total materials generated during the project period (Reuse/Recycle + Disposal = Generation)</i>						
				Tons	Cubic YD	Other Wt.
a. Total Reused/Recycled				-	-	-
b. Total Disposed				-	-	-
c. Total Generated				-	-	-

SECTION IV - CONTRACTOR'S LANDFILL DIVERSION RATE CALCULATION						
<i>Add totals from Section I + Section II</i>						
		Tons	Cubic Yards	Other Wt.		
a. Materials Re-Used and Recycled		-				
b. Materials Disposed		-				
c. Total Materials Generated (a. + b. = c.)		-	-	-		
d. Landfill Diversion Rate (Tons Only)*		#DIV/0!				

** Use tons only to calculate recycling percentages: Tons Reused/Recycled/Tons Generated = % Recycled*

Contractor's Comments (*Provide any additional information pertinent to planned reuse, recycling, or disposal activities*):

Notes:

1. Section 01 15 01A is a Division 01 General Requirement.

2. Suggested Conversion Factors: From Cubic Yards to Tons (Use when scales are not available)
 Asphalt: .61 (ex. 1000 CY Asphalt = 610 tons. Applies to broken chunks of asphalt)
 Concrete: .93 (ex. 1000 CY Concrete = 930 tons. Applies to broken chunks of concrete)
 Ferrous Metals: .22 (ex. 1000 CY Ferrous Metal = 220 tons)
 Non-Ferrous Metals: .10 (ex. 1000 CY Non-Ferrous Metals = 100 tons)

Drywall Scrap: .20
 Wood Scrap: .16

SECTION 01 31 00 - COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Coordination of Work under Contract.

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Various types of Work to be coordinated, including Owner-Furnished/Contractor-Installed products and work under separate Contracts.
- B. Section 01 31 19 – Project Meetings: Schedule appropriate meetings with Sub trades and University Representative for proper coordination.
- C. Section 01 61 00 - Basic Product Requirements: Coordination of products, especially general requirements for system completeness and product substitutions.

1.4 COORDINATION

- A. Coordination, General:
 - 1. Coordinate the Work according to provisions stated in Contract General Conditions. Do not delegate responsibility for coordination to any subcontractor.
 - a. Anticipate the interrelationship of all subcontractors and their relationship with the total work.
 - b. Resolve differences or disputes between subcontractors and materials suppliers concerning coordination, interference, or extent of work between sections. The Contractor's decisions, if consistent with the Contract Documents, shall be final. The Architect and/or University is not required to coordinate work between sections and will not do so.
 - c. Coordinate the work of subcontractors and material suppliers, so that their work is performed in a manner to minimize interference with, and to facilitate the progress of the work.
 - 2. Coordinate Work under the Contract with work under separate contracts by University.
 - 3. Coordinate utility and building services shut-downs and closures of vehicular and pedestrian thoroughfares, including access to buildings and parking areas, to minimize disruption of University activities. Notify the University of all scheduled disruptions a minimum of fourteen (14) calendar days. For disruptions that may affect other campus buildings or services, notify the University a minimum of twenty one (21) calendar days in advance of the outage.

4. Contractor shall be responsible for providing anchorage, blocking, joining and other detailing as required to provide complete project.
 5. Do not obstruct spaces required by Code in front of electrical equipment, access doors, etc.
 6. Do not cover any piping, wiring, ducts, etc., until properly inspected and approved.
 7. Remove and replace any and all Work under any Section which is not in accordance with the Contract Documents with other materials and Work which is in conformance with the Contract Documents. Repair or replace all other Work damaged by these operations at no additional cost to the University. No additional time will be granted.
 8. This work shall be coordinated with all associated Work in a manner that will insure that all work will be accomplished as rapidly as the progress of the project will permit and so that no work will be delayed for want of associated work.
- B. Coordination of OFCI Products: Contractor shall cooperate with University and others as directed by University's Representative in scheduling and sequencing the incorporation into the Work of Owner Furnished/Contractor Installed (OFCI) products identified in the Contract Drawings and Specifications. Sufficient lead times shall be provided by the contractor and the construction schedule will clearly indicate both lead times and delivery dates.
- C. Relationship of Contract Documents: Drawings, Specifications and other Contract Documents in the Project Manual are intended to be complementary. What is required by one shall be as if required by all. What is shown or required, or may be reasonably inferred to be required, or which is usually and customarily provided for similar work, shall be included in the Work.
- D. Discrepancies in Contract Documents: In the event of error, omission, ambiguity or conflict in Drawings or Specifications, Contractor shall bring the matter to attention of the Architect in a timely manner during the bidding period, for determination and direction by the Architect in accordance with provisions of the Contract General Conditions.
- E. Construction Interfacing and Coordination: Layout, scheduling and sequencing of Work shall be solely the Contractor's responsibility.
1. Contractor shall verify, confirm and coordinate field measurements so that new construction correctly and accurately interfaces with conditions existing prior to construction.
 2. Contractor shall bring together the various parts, components, systems and assemblies as required for the correct interfacing and integration of all elements of Work. Contractor shall coordinate Work to correctly and accurately connect abutting, adjoining, overlapping and related elements, including work under separate contracts by University, utility agencies and companies.
- 1.5 COORDINATION OF SUBCONTRACTS AND SEPARATE CONTRACTS**
- A. Superintendence of Work: Contractor shall appoint a field superintendent and a project manager, who shall directly and full time supervise and coordinate all Work of the Contract.

- B. Subcontractors, Trades and Materials Suppliers: Contractor shall require all subcontractors, trades, crafts and suppliers to coordinate their portions of Work with the Contractor's field superintendent to prevent scheduling, sequencing, dimensional and other conflicts and omissions.
- C. Coordination with Work Under Separate Contracts: Contractor shall coordinate and schedule Work under the Contract with work being performed for Project under separate contracts by University, serving utilities and public agencies. Contractor shall make direct contacts with parties responsible for work of the Project under separate contracts, in order to provide timely notifications and to facilitate information exchanges.

1.6 MECHANICAL AND ELECTRICAL COORDINATOR

- A. Mechanical and Electrical Coordinator: Contractor shall employ and pay for services of a person, technically qualified and administratively experienced in field coordination for the type of mechanical and electrical Work required for this Project, for the duration of the Work.
 - 1. Work out all "tight" conditions involving work of various sections in advance before installation. If necessary, and before work proceeds in these areas, prepare supplementary drawings for review showing all work in "tight" areas.
 - 2. Provide supplementary drawings and additional work necessary to overcome "tight" conditions at no increase in contract price. Refer to Section 01 33 00, "Submittal Procedures."
 - 3. Coordinated layout shop drawings shall be dimensionally accurate and detailed, giving complete dimensions of all locations, elevations, and clearances. Show exact locations of the following:
 - a. Ductwork
 - b. Piping, including fire protection systems.
 - c. Valves and piping specialties, including all air vents and drains.
 - d. Dampers
 - e. Access doors
 - f. Control and electrical panels
 - g. Adjustable frequency controllers
 - h. Motor control centers and transformers
 - i. Disconnect switches
 - j. Elevator equipment
 - k. Electrical cable trays and main conduits
 - l. Owner-furnished, Contractor-installed equipment
 - m. Hand and Tool space for installation and maintenance work including component removal and replacement
 - n. Access to components for installation and maintenance work (ladder, scissor lift access, etc.). Notify University of potential operational conflict for routine maintenance operations based on physical installed location of components.
 - 4. Coordinated layout shop drawings shall show actual architectural and structural constraints and site conditions.

5. Coordination:
 - a. Fully coordinate work between all trades with actual architectural, structural, and site conditions.
 - b. Coordinate all adjustments required. Clearly identify by circling these adjustments on the coordinated layout shop drawings.
 - c. If Contractor has specific questions regarding coordination of the installation with structural, architectural and site conditions and work between trades, submit same with appropriate shop drawings documenting areas in question with Contractor's proposed installation.

6. Submission and review of coordinated layout shop drawings:
 - a. Prepare reproducible drawings.
 - b. Submit to each trade for review of space allocated to all trades.
 - c. Revise drawings to compensate for review by each trade.
 - d. Review revisions with each trade.
 - e. Submit to Architect for review.
 - f. Review of coordinated layout shop drawings is only for verification that Contractor has performed coordination work as specified herein.
 - (1) Review does not include verification of exact dimensions, clearances, arrangements and/or compliance with codes.

7. Final coordinated layout shop drawings shall show that all trades affected have made reviews and shall be signed by each trade at completion of coordination.
 - a. General Contractor is to assure that each trade has coordinated work with other trades.
 - b. Include stamp with labeled space for each trade to sign on each submittal indicating that layout shop drawing has been coordinated.
 - c. No layout shop drawing will be reviewed without stamped and signed coordination assurance by General Contractor.

8. Coordinated layout shop drawings showing work of all trades are required. Individual trade layout shop drawings will not be accepted.

1.7 SUBMITTALS

- A. Coordination Documents: Coordinate shop drawings, diagrams and other specified in various product Sections of the Contract Specifications. Submit coordination drawings and schedules as specified below, prior to submitting shop drawings, product data, and samples.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 – EXECUTION

3.1 COORDINATION REQUIRED

- A. Coordinate Work specified in Division 13 - Special Construction, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Integrated Automation, Division 26 – Electrical, Division 27 – Communications, Division 28 – Electronic Safety and Security, coordinate within each Division, between these Divisions and with Work specified in other Divisions.
- B. Coordinate progress schedules, including dates for submittals and for delivery of products.
- C. Conduct meetings with suppliers, installers and others concerned with the Work including University's Representative, to establish and maintain coordination of layout, sequencing and completion of various elements of Work.
- D. Conduct meetings with installers and others concerned with the Work, to properly integrate various mechanical and electrical systems, to facilitate construction and to provide proper access and work space for maintenance, renovation and improvement of system components. Include participation by representatives of University, including maintenance personnel.
- E. Assist in resolution of conflicts by providing technical advice, coordination drawings and three dimensional representations of integrated system components, including computer and physical models as necessary.
- F. At construction progress meetings, report on progress of Work to be adjusted under coordination requirements and any necessary changes in sequencing and scheduling of Work.
- G. Contractor shall record and transmit minutes of coordination meetings and reports to University's Representative, Architect, Architect's consultants (as applicable) and to meeting participants.

3.2 COORDINATION DOCUMENTS

- A. Coordination Drawings and Models: Contractor shall prepare coordination drawings and three-dimensional models (BIM or similar), in computer form and in physical form as necessary, to organize layout and installation of mechanical and electrical products for efficient use of available space, for proper sequence of installation, for integration with building structure, for future maintenance and renovation, and to identify potential conflicts between systems and elements.
- B. System Services: Contractor shall identify on coordination drawings and models all plumbing and electrical power and signal services required for each component of each system.
 - 1. Contractor shall certify that characteristics of services and controls are correct for each component.
 - 2. Certification shall be in written form and signed by Contractor and mechanical and electrical coordinator.
- C. Responsibility and Services Matrix: Contractor shall prepare a schedule or matrix identifying elements of mechanical and electrical Work requiring coordination, as specified in all Divisions of the Contract Specifications.
 - 1. Include identification of parties having responsibilities related to each element of Work and

describe what that responsibility shall be.

2. Include required off-site and on-site tests and inspections for various elements of Work.
 3. Include identification of administrative activities related to each element of mechanical and electrical Work, such as product data, shop drawings, coordination drawings, samples, mock-ups, test reports for each element of Work.
 4. Include identification of elements of Work requiring temporary services.
- D. Maintenance and Disposition of Coordination Documentation: Maintain coordination documents, including models, for duration of the Work, recording all changes. After review of original and revised documents and models by University's Representative and Architect, submit documents and models as part of Project record documents. See Section 01 78 39, Project Record Documents.

3.3 COORDINATION OF SUBMITTALS

- A. Submittal Reviews by Mechanical and Electrical Coordinator: In addition to specified review actions by Contractor, specified in Section 01 33 00 - Submittals Procedures, all product data, shop drawings and samples shall be reviewed by the mechanical and electrical coordinator for proper coordination of various elements of Work, as described in the preceding Article titled "Coordination Documents."
1. Include Owner-furnished/Contractor-installed (OFCI) products.
 2. Include products to be provided (furnished and installed) under separate contracts by University, to the extent that information is provided in the Contract Documents and supplemental instructions from University's Representative.
 3. Review by Contractor shall be completed prior to submission of product data, shop drawings and samples to Architect for review.
 4. Indicate review actions by Contractor by signed review stamp and other appropriate notations on submittals.
 5. Coordinate with other review actions to be taken by Contractor, as specified in Section 01 33 00 - Submittals Procedures.
- B. Field Conditions: Contractor shall verify field dimensions and clearances and relationship to available space and anchoring provisions. Report conflicts in writing to the Architect and the University's Representative.
- C. Product Characteristics: Contractor shall:
1. Verify compatibility of equipment and other elements requiring plumbing, HVAC and electrical services and signals with services to be provided.
 2. Verify motor voltages and control characteristics.
 3. Coordinate controls, interlocks, wiring of pneumatic switches, and relays.

4. Coordinate wiring and control diagrams.
5. Review the effect of changes in one element of the Work of other elements of the Work. Identify conflicts and report conflicts in written and graphic form to the Architect and the University's Representative.
6. Verify information provided in maintenance and operating instructions and coordinate preparation of maintenance and operation data. See Section 01 78 23 - Operation and Maintenance Data.

3.4 COORDINATION OF SUBSTITUTIONS AND MODIFICATIONS

- A. Review of Proposed Substitutions: See Section 01 63 00 - Product Substitution Procedures. Contractor shall review Contractor's proposals and requests for substitution prior to submission to Architect.
1. Contractor shall verify compliance with Contract Documents and shall certify compatibility with other elements of the Work, including proper integration with building structure, load limitations, operating and maintenance space and accessibility provisions, and suitability for available building services, including plumbing and electrical power and signal systems.
 2. Contractor shall prepare and submit recommendation for action regarding proposals, including identification of related changes in other elements of the Work.

3.5 SYSTEM AND EQUIPMENT START-UP

- A. Observations of System and Equipment Activation and Start-Up: Contractor shall observe activation and start-up of systems and equipment, including all Work specified in Divisions 2 through 49 with connections to utilities, building services and controls.
1. Contractor shall verify that utilities, building services and control systems are properly connected, complete and functional within criteria of manufacturer and criteria indicated in the Contract Documents.
 2. Contractor shall verify that activated elements are properly anchored and that operating components operate properly according to the component's intended design.
 3. Contractor shall verify that activated elements of the Work are in operable condition according to normal operating characteristics required by the manufacturer and the Contract Documents.
 4. Should adjustments be necessary to activated elements, Contractor shall advise the Architect and University's Representative of necessary actions and shall observe that proper actions are performed to achieve required operating characteristics.
- B. Observations of System and Equipment Demonstrations: Contractor shall observe performance demonstrations including equipment demonstrations to Architect and University's Representative. Record times and additional information required for operation and maintenance manuals.

- C. Documentation of Observations of Activation, Start-Up, Adjustment and Demonstration: Contractor shall keep written record of activation, start-up, operational tests and inspections and necessary adjustments and re-tests and re-inspections.
1. Documentation shall include record of time and date of activation, start-up, operational tests and inspections and shall include measured results of tests and inspections.
 2. Documentation shall be submitted to University's Representative and Architect.

3.6 INSPECTION AND ACCEPTANCE OF EQUIPMENT

A. Contract Completion Review:

1. Prior to Contract Completion review, Contractor shall verify that each component and system has been properly adjusted, cleaned, lubricated, inspected and tested, and is ready operation and use.

END OF SECTION 01 31 00

PRECONSTRUCTION MEETING AGENDA

Project Name _____

Contract No. _____ **Project No.** _____

Campus _____ **Date** _____

Room _____ **Time** _____

1. Introductions: Statement of Purpose (by Chairman) - Administration of Construction. Each person present will introduce himself (or herself) and briefly explain the role he or she will play in relation to the project, if any. Also print your name, organization and phone number on the sign-in sheet being circulated (copies will be distributed).

2. Explain/discuss:

A. Responsibility of each party involved in the project.

B. Inspection procedures.

C. Testing procedures labs. Soils: _____ Materials: _____

D. Progress schedule.

E. Submittals and approvals. Contractor to Architect, transmittals only to Inspector. Architect return approved submittals with a copy to Inspector.

F. Routing of correspondence. Contractor, Architect, Inspector, University, Construction Administrator. Each copies the others.
Changes, disputes, complaints, claims, etc.

G. Prevailing wage, CSU Labor Compliance Program (if applicable), EEO, Preliminary Notices, Insurance.

H. Payment procedure. Bid cost breakdown. (Forms 702.12, 702.17 and 702.21.

- I. Change Order procedure: Change Proposal, Cost Request Bulletin, approved design and cost, Field Instruction, T&M, Change Order.
- J. Field Instructions (Form 702.22).
- K. Check and Final Inspections. (Punch List form 702.07).
- L. Guarantee (Form 702.19), as-built plans, turn-over items, balance report.
- M. Notice of Completion.
- N. Retention payment.

3. Review:

- A. Special coordination problems, utilities, traffic, parking, fence, keys.
- B. Restrictions of contract operations, if any.
- C. Ingress and egress to project to site.
- D. Use of State property.
- E. Demolition work.
- F. Safety.
- G. Utilities shut down.

4. Confirm:

- A. Survey benchmarks and their location, and critical layout control.
- B. Points of tie-in to existing utilities.
- C. Existing condition of site and adjacent areas and structures (Site Survey Form 702.08).
- D. Source of temporary utilities.

5. Determine:

- A. Contractor's plan of operation.
- B. Field office location.
- C. Project Manager: _____
Superintendent: _____
- D. Contractor's off-hour contact in case of emergency:
_____ Phone # _____
- E. Security arrangements contemplated by the Contractor.
- F. Starting date of project: _____

6. Resolve:

- A. Questions of contract requirements.
- B. Job meeting procedure with Architect, Inspector, and Contractor.

Time and date: _____

- C. Shop drawings and submittals requirements.
- D. Special tests: _____
- E. Anticipated changes.
- F. Color submittals. Who confirms? _____

7. University to outline campus requirements.

8. Anyone have anything to add while this group is assembled?

SECTION 01 31 19 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 REQUIREMENTS INCLUDED

- A. Preconstruction meeting.
- B. Construction progress meetings.
- C. Pre-installation conferences.

1.3 RELATED REQUIREMENTS

- A. Section 01 31 00 – Coordination: General requirements for coordinating the work, meetings required to properly coordinate the work are defined.
- B. Section 01 32 26 - Construction Progress Reports: General requirements for construction progress reports, to be reviewed at construction progress meetings.
- C. Section 01 33 00 - Submittals Procedures: Status of submittals to be reviewed at construction progress meetings.
- D. Section 01 45 00 - Quality Control: General requirements for construction quality, to be reviewed at construction progress meetings
- E. Section 01 77 00 - Contract Closeout Procedures: Contract closeout meeting.

1.4 PRECONSTRUCTION MEETING

- A. Preconstruction Meeting: University's Representative will administer a preconstruction meeting immediately prior to Contractor mobilization onto the project site.
 - 1. Representatives of the Trustees, the Contractor, Architect, and Architect's Consultants, Special Inspector, Inspector of Record, Commissioning Agent and other campus representatives, as appropriate, will attend.
 - 2. Contractor and first tier subcontractors, as appropriate, shall attend.
- B. Schedule: Schedule preconstruction meeting within fourteen (14) days of construction start date established in the Notice to Proceed.

- C. Location: Preconstruction meeting will be held at a location as directed by the University's Representative.
- D. Agenda: Preconstruction meeting shall cover the following topics as a minimum.
 - 1. Special Project Procedures: Site access restrictions, if any, and requirements to avoid disruption of operations at adjoining facilities. University to present requirements for use of premises.
 - 2. Designation of Key Personnel: Contractor shall designate key personnel and provide a name and address list that includes the following.
 - a. Contractor: Project Manager and Superintendent.
 - b. Major subcontractors: Principal/Project Manager and Superintendent.
 - c. Major materials suppliers: Contact person.
 - d. After hours or weekend contact
 - 3. Subcontractors List: Distribute and discuss list of subcontractors and suppliers.
 - 4. Coordination: Review requirements for Contractor's coordination of Work. Review sequence and schedule for work being performed for University under separate contracts. Discuss coordination of construction to minimize impacts on continuing Campus operations.
 - 5. Project Communication Procedures: Review requirements and administrative requirements for written and oral communications.
 - 6. Construction Schedule: Distribute and discuss initial construction schedule and critical work sequencing of major elements of Work, including coordination of Owner-Furnished/Contractor-Installed (OFI) products and work under separate contracts by serving utility agencies and companies and University.
 - 7. Campus and Site Security: Review requirements for Contractor to develop and implement site security.
 - 8. Safety Program: Review requirements for Contractor to develop and implement safety program in compliance with Contract General Conditions.
 - 9. Site Access by University's Representative and Architect: Review requirements and administrative procedures Contractor may wish to institute for identification and reporting purposes.
 - 10. Permits and Fees: Review Contract requirements and review schedule and process for obtaining any required permits and paying fees. (Parking permits)
 - 11. Project Layout: Review requirements for laying out of Work, including surveying requirements.
 - 12. Construction Facilities: Designate storage and staging areas, construction office areas and parking areas and review site access requirements.

13. Temporary Utilities: Requirements for establishing and paying for temporary water, power, lighting and other utility services during construction, including metering and allowances. Refer to Section 01 51 00 - Temporary Utilities.
14. Construction Progress Schedules: Review requirements for preparation and updating of construction progress and submittals schedules.
15. Payment Procedures: Review requirements for preparation and submission of applications for progress payments and for final payment.
16. Change Procedures: Review requirements and administrative procedures for Change Orders, Field Instructions and Contractor's Requests for Interpretation (RFI).
17. Submittals Administration: Review administrative procedures for shop drawings, product data and samples submittals and review of preliminary Submittals Schedule.
18. Materials and Equipment: Review substitution or equal product requirements; review schedule for major equipment purchases and deliveries; review materials and equipment to be provided by University (OFCl products).
19. Testing and Inspection: Review tests and inspections to be performed by the following.
 - a. Independent testing and inspection agency.
 - b. Manufacturers and installers.
 - c. Serving utilities and public agencies.
 - d. Authorities having jurisdiction.
 - e. Commissioning Agent
20. Operation and Maintenance Data: Format and content of operation and maintenance manuals. Refer to Section 01 78 23 - Operation and Maintenance Data.
21. Instruction of University's Personnel: Review requirements and scheduling of instruction of personnel specified in Section 01 79 00 - Demonstration and Training and in various Sections through all Divisions of the Specifications.
22. Starting and Adjusting Procedures: Review requirements of starting and adjusting operating components. Refer to Section 01 75 00 - Starting and Adjusting Procedures.
23. Project Record Documents: Review requirements and procedures for preparing, reviewing and submitting project record drawings and specifications in Section 01 78 39.
24. Construction Cleaning: Review requirements for progress and final cleaning specified in Section 01 74 00 - Cleaning Requirements.
25. Contract Closeout: Review requirements specified in Section 01 77 00 - Contract Closeout Procedures, including procedures for filing of Notice of Completion, final payment and submittals.

1.5 CONSTRUCTION PROGRESS MEETINGS

- A. Construction Progress Meetings: Meetings will be held to review progress and quality of construction. The essence of the discussion of each meeting shall be entered into the written record (minutes) of the meeting by the Architect or the University Representative designee.
- B. Schedule: Construction progress meetings shall be periodically scheduled throughout progress of the Work. Frequency shall be as determined necessary for progress of Work. Generally, it is intended that construction progress meetings be held at weekly intervals.
- C. Administration: Architect shall make physical arrangements for meetings. Architect shall prepare agenda with copies for participants, preside at meetings, record minutes and distribute copies within two working days to University's Representative, Contractor, participants and those affected by decisions made at meetings. Each discussion item at construction progress meetings shall be numerically identified and carried through subsequent meeting minutes until resolved.
- D. Attendance: Contractor's project manager and jobsite superintendent shall attend each meeting. Contractor's subcontractors and suppliers may attend as appropriate to subject under discussion. University's Representative will attend each meeting. Architect's consultants will also attend, as appropriate to agenda topics for each meeting and as provided in University-Architect Agreement.
- E. Suggested Agenda for Each Construction Progress Meeting:
 - 1. Meeting Minutes: Review and correct, if necessary, minutes of previous meeting.
 - a. Unless published minutes are challenged in writing prior to the next regularly scheduled progress meeting, they will be accepted as properly stating the activities and decisions of the meeting.
 - b. Persons challenging published minutes shall reproduce and distribute copies of the challenge to all indicated recipients of the particular set of minutes.
 - c. Challenge to minutes shall be settled as priority portions of "old business" at the next regularly scheduled meeting.
 - 2. Old Business: Active discussion topics carried over from previous meetings.
 - 3. Progress of the Work: Since last meeting and proposed progress.
 - a. Identify potential problems which might impede progress. This shall include upcoming University Holidays or University required alternate work schedules.
 - b. Develop corrective measures and procedures, including but not necessarily limited to additional manloading to regain planned schedule.
 - c. Review three-week "look ahead" construction schedule, including identification of conflicts and delays.
 - 4. Ordering Status: Review status of long-lead time equipment and materials delivery affecting construction progress.
 - 5. RFI Status: Review status of Requests for Interpretation (RFI) status.
 - 6. Submittals Status: Review shop drawings, product data and samples submission and review status.

7. Contract Modifications: Pending Change Orders and Field Orders. Review status of proposed substitutions.
 8. New Business: New topics of discussion affecting construction progress and quality.
 - a. Inspections – Both outstanding issues to discuss and upcoming inspections to be scheduled.
 3. Quality Control: Review maintenance of quality standards and identification of non-conforming Work, including proposed remedial measures to be taken by Contractor.
 4. Project Record Documents: Status of project record drawings and specifications.
 5. Environmental and Safety Issues.
 - a. SWPPP controls and measures
 - b. Air Pollution issues
 - c. Noise Controls
 - d. Site Safety
 - e. Public Pedestrian and Traffic Control Measures
 6. Other items affecting progress and quality of the Work.
- F. Meeting Time and Location: As mutually agreed by the Architect, the Contractor, and the University's Representative at on-site location. Typically held weekly at the beginning or end of each week.
- G. Special Meetings: As necessary, the Architect, the Contractor, or the University's Representative may convene special meetings to discuss specific construction issues in detail and to plan specific activities.

1.6 PRE-INSTALLATION CONFERENCES

- A. Pre-Installation Conferences: When specified in individual product specification Sections, convene a pre-installation conference prior to commencing Work specified in individual product Sections.
1. Require attendance by representatives of firms whose activities directly affect or are affected by Work specified in the Section.
 2. Review conditions of installation, preparation and installation procedures and coordination with related Work and work under separate contracts.

1.7 CONTRACT COMPLETION MEETING

- A. Contract Closeout Meeting: As specified in Section 01 77 00 - Contract Closeout Procedures.
- a. It is recommended that this meeting be scheduled four (4) to six (6) weeks prior to the scheduled contract completion date. Refer to Section 01 77 00 for additional information on Punch List meetings, final completion submittals and final payments.

PART 2 - PRODUCTS

- A. Contractor shall provide all necessary products as necessary to facilitate a productive meeting. This shall include any product samples, manufacture's literature, mockups, details, or any similar item.

PART 3 - EXECUTION

Not applicable to this Section.

END OF SECTION 01 31 19

SECTION 01 32 00 - ELECTRONIC PROJECT MANAGEMENT SYSTEM

1.00 GENERAL

1.01 DESCRIPTION

- A. This Section is in addition to the Contract General Conditions.
- B. The Contractor shall be required to use the University's Electronic Project Management (EPM) system, Procore, for electronic construction management document control and communications between the University, Architect of Record, other project-related consultants, and Contractor. The system will be maintained and owned by the University but operated collaboratively by the Project Team.
- C. The EPM system will contain information the following information available to the contractor and project team:
 - 1. Submittal Information and Logs including weekly and monthly schedule updates
 - 2. Requests for Information and Logs
 - 3. Inspection Requests / Reports
 - 4. Non-Compliance Inspection Reports
 - 5. Project Photographs
 - 6. Project Meeting Minutes
 - 7. Proposed Change Orders, Change Orders
 - 8. Electronic Drawings, Sketches, ASIs
 - 9. Other Documentation as determined by the University's Representative.
- D. All Request For Information (RFIs) and Inspection Requests, shall submitted by the Contractor to the University electronically, via Procore.
- E. The University will **NOT** accept faxed and/or hand written documentation of RFIs, RFI Sketches, and/or Inspection Requests.
 - 1. The Contractor shall be solely responsible for data entry via the Electronic Project Management System Website for the generation of project related documentation.
 - 2. The contractor shall be solely responsible for the scanning of sketches / drawings as necessary for the electronic submittal and attachment of necessary information related to RFIs.
 - 3. Contractor shall supply field personnel with all necessary computer equipment necessary to enter documentation electronically.

- F. Submittals may be submitted via hard copy per Section 01 33 00 Submittals with electronic documents for all paperwork and shall include photographs of physical product submittals.

1.02 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall have sufficient computer(s) with capabilities to access the system at their on site and off site project offices.
- B. The Contractor shall submit to the University a comprehensive list of users. The University will use this information for no other purpose than to establish the necessary accounts for use by each individual.
- C. All personnel shall have sufficient computer skills required to access the Internet, log on to the EPM system, and utilize the system. The Contractor may request the University to provide training and technical support to the Contractor's personnel for use of the EPM system. The cost of the training session will be borne by the attendees. The Contractor shall plan on an average of 4-hours training for each of the Contractor's personnel who will be using the system. Having the above capability in place onsite is a condition precedent to processing the Contractor's first payment request.

1.03 OFFICIAL RECORDS

- A. The documentation and records maintained on the EPM system will be the "Official Records" for the project. This documentation shall be the records for the adjudication of any and all disputes. At the conclusion of the project all records can be made available via Adobe "pdf" at the request of the Contractor.

END OF SECTION 01 32 00

SECTION 01 32 26 - CONSTRUCTION PROGRESS REPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Construction progress reports.

1.3 RELATED SECTIONS

- A. Section 01 31 19 - Project Meetings: Review of construction progress and submittals status at Project meetings.
- B. Section 01 77 00 - Contract Closeout Procedures: Notice by Contractor of progress of the Work sufficient for Contract Completion review and Acceptance by University.

1.4 CONSTRUCTION PROGRESS REPORTS

- A. Daily Log: Contractor shall maintain a written daily log at the job site with the following information as a minimum:
 - 1. Date.
 - 2. Weather conditions.
 - 3. Subcontractors and trades performing Work under the Agreement on the Site, and number of workers each and number of hours worked by each worker.
 - 4. Others on the Site performing work for University under separate contracts.
 - 5. List of visitors to site, giving name, company or agency affiliation and telephone number.
 - 6. Descriptions of situations and circumstances which could delay normal progress of Work or which could be basis of claim for change in Contract Time or Contract Sum.
 - 7. Changes to Work and who authorized changes.
 - 8. Contractor shall describe all damage, deterioration, soiling, staining or similar conditions in accordance with 01-45-00 QUALITY CONTROL. Contractor may note responsible party for the damage.
 - 8. Comments, as Contractor determines are appropriate for Project record.
- B. Submission of Logs: Submit one copy of daily logs to University's Representative and Architect at weekly intervals, for review at Construction Progress Meetings.

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

Not applicable to this Section.

END OF SECTION

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Administrative requirements
- B. Construction Progress Schedule Submittal
- C. Contractor's review of submittals.
- D. Architect's review of submittals.
- E. Product data submittals.
- F. Shop drawing submittals.
- G. Sample submittals.
- H. Manufacturer's Instructions
- I. Reports of results of tests and inspections.
- J. Operations and Maintenance Data submittals
- K. Certificates

1.3 RELATED SECTIONS

- A. Section 01 31 13 – Project Coordination
- B. Section 01 31 26 – Electronic Communications Protocol
- C. Section 01 45 00 - Quality Control: Test and inspection reports.
- D. Section 01 77 00 - Closeout Procedures: Submittals for occupancy, Acceptance and Final Payment.
- E. Section 01 78 23 - Operation and Maintenance Data: Requirements for preparation and submission.

1.4 DEFINITIONS

- A. Shop Drawings, Product Data and Samples: Instruments prepared and submitted by Contractor, for Contractor's benefit, to communicate to Architect the Contractor's understanding of the design intent, for review and comment by Architect on the conformance of the submitted information to the general intent of the design. Shop drawings, product data and samples are not Contract Documents. Drawings, diagrams, schedules and illustrations, with related notes, are specially prepared for the Work of the Contract, to illustrate a portion of the Work. Approval of the shop drawings does not relieve the contractor of their duty to perform or install any component of the project.
- B. Product Data: Standard published information ("catalog cuts") and specially prepared data for the Work of the Contract, including standard illustrations, schedules, brochures, diagrams, performance charts, instructions and other information to illustrate a portion of the Work.
- C. Samples: Physical examples that demonstrate the materials, finishes, features, workmanship and other characteristics of a portion of the Work. Accepted samples shall serve as quality basis for evaluating the Work.
- D. Other Submittals: Technical data, test reports, calculations, surveys, certifications, special warranties and guarantees, operation and maintenance data, extra stock and other submitted information and products shall also not be considered Contract Documents but shall be information from Contractor to Architect to illustrate a portion of the Work for confirmation of understanding of design intent.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Administrative Requirements for Submittals: Submittals shall be made in accordance with requirements specified herein and in other Divisions of the Specifications. See also the Contract General Conditions for additional requirements; especially those regarding requests for alternatives or equals and for substitutions.
 - 1. All required submittals, with the exception of O&M manuals, close-out submittals, and mock-ups required to be installed concurrent with specific construction activities, shall be submitted within 90 calendar days after Notice to Proceed.
- B. Contractor Coordination of Submittals: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The Architect will return without action submittals requiring coordination with other submittals until related submittals are coordinated.
- C. Submittal Log: Prior to proceeding with affected work, Contractor shall prepare and submit a Submittal Log, which lists submittal items per the product specifications for review and approval by University's Representative and Architect. Contractor shall allow seven (7) calendar days for Trustees review. Submittal Log shall identify all specified submittals to be made and shall serve as checklist for submittals.
1. Maintain accurate submittal log for duration of Contract. Indicate current status of all submittals at all times. Submit log at progress meeting and as otherwise requested by University Representative or Architect.
 2. Format shall be suitable for Project and shall be subject to acceptance by University's Representative and the Architect. Comply with directions by University's Representative and the Architect for scope and format of Submittals List.
 3. Submittals list shall include the following submittal types and headings:
 - SD = Shop Drawings are required
 - PD = Product Data required
 - SA = Samples required
 - CO = Color samples required
 - SS = Site Sample installations are required
 - LM = List of Materials
 - RD = Record Drawings required
 - CE = Certificates are required
 - PR = Manufacturer's instructions or specifications required
 - OM = Operation and Maintenance manuals are required
 - EQ = Maintenance materials/equipment are required
 - WA = Warranties and/or guarantees are required
 - LR = Laboratory Reports are required
 - FT = Factory Test reports are required
 - ST = Site Test reports required
 - RP = Submittal to the Architect for record purposes only and not for review or approval
 - O = Other submittal requirements as specified in Section

2. Sample Table:

Section	SD	PD	SA	CO	SS	LM	RD	CE	PR	OM	EQ	WA	LR	FT	ST	RP	O
05 12 00	x					x											
09 25 00		x			x	x		x					x		x		
10 81 00		x	x														

- D. Transmission of Submittals: Submittals shall be processed electronically (with exceptions such as

product and material samples or otherwise designated or approved by the University Representative). Transmit all submittals from Contractor to Architect via Electronic Project Management (EPM) system, unless otherwise directed, using a transmittal form for each one. Submittals received from sources other than the Contractor will be returned without action. Include all information specified below for identification of submittal and for monitoring of review process.

1. Architect will provide example Letter of Transmittal, if requested.
 2. Submittals shall be concurrently made available via EPM to University's Representative for review.
- E. Timing of Submittals: Make submittals sufficiently in advance of construction activities to allow shipping, handling and review by the Architect and Architect's consultants. Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
1. The Architect will make desired corrections and consolidate relevant Trustees comments within fifteen (21) calendar days and return the submittal to the Contractor via EPM system. Submittals, which require coordination with other submittals, may require more than fifteen (21) calendar days review time. Submittals that require selection of colors will be reviewed. Color selection may not be provided until all submittals requiring color selection have been received and reviewed, and color selections have been approved by the Trustees.
 2. Make corrections required by the Architect and submit via EPM system for final review and distribution.
 3. If an intermediate submittal is necessary, process the same as the initial submittal.
 4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Architect sufficiently in advance of the Work to permit processing.
- F. Submittals Identification:
1. Provide a space on all submittals electronically approximately four-inches by five-inches on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken. Include the following information on the label for processing and recording action taken:
 - a. Project name and Trustees project number
 - b. Submission date
 - c. Name and address of Architect
 - d. Name and address of Contractor
 - e. Name and address of subcontractor
 - f. Name and address of supplier
 - g. Name of manufacturer
 - h. Number and title of appropriate Specification Section
 - i. Drawing number and detail references, as appropriate.

2. Identify each element on submittal by reference to Drawing sheet number, detail, schedule, room number, assembly or equipment number, Specifications article and paragraph, and other pertinent information to clearly correlate submittal with Contract Drawings. On the submittal transmittal form or separate sheet record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information submitted complies with requirements of the Contract Document. The Architect's review of such submittals or shop drawings or product data shall not relieve the Contractor of responsibility for deviations from the drawings or specifications.

3. Identify each submittal by Specification Section number followed by a number indicating sequential submittal for that Section. Resubmittals shall use same number as original submittal, followed by a letter indicating sequential resubmittal. For example:

09 26 13-01-01 First submittal for Section 09 26 13 - Gypsum Veneer Plastering.

09 26 13-02-01 Second submittal for Section 09 26 13 - Gypsum Veneer Plastering.

09 26 13-02-02 Resubmittal of second submittal for Section 09 26 13 - Gypsum Veneer Plastering.

09 26 13-02-03 Second resubmittal of second submittal for Section 09 26 13 - Gypsum Veneer Plastering.

4. Place a permanent label or title block on each submittal electronically for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

G. Grouping of Submittals: Unless otherwise specifically permitted by the Architect, make all submittals in groups containing all associated items. The Architect may reject partial submittals as incomplete or hold them until related submittals are made.

H. Unsolicited Submittals: Unsolicited submittals may be returned without being reviewed.

I. Record Submittals: When record submittals are specified, submit in accordance with the Electronic Project Management System requirements. Record submittals will not be reviewed but will be retained for historical and maintenance purposes.

J. Revisions: Revisions to original submittal list and schedule will only be accepted by University Representative and Architect when revisions are required by circumstances not reasonably anticipated by Contractor during preparation of original schedule. Submit revisions not later than 20 calendar days following the date that the need for revision became necessary.

1.6 CONSTRUCTION PROGRESS SCHEDULE SUBMITTAL

A. Submit as specified in the Contract General Conditions under Schedule and Section 01 32 26 for Construction Progress Documentation.

1.7 CONTRACTOR'S REVIEW OF SUBMITTALS

A. Contractor's Review of Submittals: Prior to submission to Architect for review, Contractor shall review each submittal for completeness and conformance to specified requirements. Contractor

shall stamp each submittal with a review action stamp and sign each copy of submittal. Submittals without stamp and signature will not be reviewed and will be returned. Electronic signatures are acceptable but will need to be authenticated during the submittal process. Contractor's submittal action stamp shall certify the following actions by Contractor:

1. Field measurements have been determined and verified.
2. Conformance with requirements of Contract Drawings and Specifications is confirmed.
3. Catalog numbers and similar data are correct.
4. Work being performed by various subcontractors and trades is coordinated.
5. Field construction criteria have been verified, including confirmation that information submitted has been coordinated with the work being performed by others for University and actual site conditions.
6. All deviations from requirements of Drawings and Specifications have been identified and noted.
7. Contractor shall certify that submittals have been reviewed and approved:

Stamp Submittals utilizing the following language:

"The undersigned certifies this submittal has been reviewed and approved with respect to the means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incidental thereto; and also warrants that this submittal complies with the Contract Documents and comprises no variation thereto.

Signature: _____ Date: _____
Name Printed: _____ Title _____
Contractor Name: _____

8. Submittals not certified by being stamped and signed by Contractor will be returned without action, as will submittals which, in University Representative's or Architect's opinion, have not been adequately reviewed and coordinated by Contractor.
- B. Changes in Work: Changes in the Work shall not be authorized by submittal review actions. No review action, implicit or explicit, shall be interpreted to authorize changes in the Work. Changes shall only be authorized by separate written direction from the University Representative, in accordance with the Contract General Conditions.
- C. Allow sufficient review time so that installation will not be delayed as result of time required to process submittals, including time for resubmittals.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of Work so processing will not be delayed by need to review submittals concurrently for coordination.
 - a. University Representative and Architect reserve right to withhold action on submittal requiring coordination with other submittals until related submittals are received.
 3. Allow additional time if processing must be delayed to permit coordination with subsequent submittals.
 4. If intermediate submittal is necessary, process same as initial submittal.
 5. Allow same time for reprocessing each submittal as allowed for processing original submittal.
 6. No extension of Contract Time will be authorized because of failure to transmit submittals to University Representative sufficiently in advance of Work to permit processing.
- D. Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to University Representative using Submittal Transmittal form attached at the end of this section.
1. Submittals received from sources other than Contractor will be returned without action.
 2. Number each submittal and resubmittal as indicated in approved Submittal Schedule.
 3. Submittals forwarded without a completed Submittal Transmittal form will be returned without review.
 4. Submittals shall be submitted electronically unless they are related to materials and products.

1.8 REVIEW OF SUBMITTALS BY UNIVERSITY'S REPRESENTATIVE AND ARCHITECT

- A. Review of Submittals by University's Representative and Architect: Submittals shall be a communication aid between Contractor and Architect by which interpretation of Contract Documents requirements may be confirmed in advance of construction.
1. Reviews by University's Representative, Architect and Architect's consultants shall be only for general conformance with the design concept of the Project and general compliance with the information given in the Drawings and Specifications.
 2. The Architect's review shall not be construed as an "approval," or to relieve the Contractor(s) and material suppliers of responsibility for errors or omissions in the submitted documents.
 3. Acceptance of a specific item does not include acceptance of the assembly of which the item is a component.
 4. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Architect will review each submittal, mark to indicate action taken, and return promptly via EPM system.

B. Review Action: Architect will stamp each submittal with a uniform, self-explanatory action stamp.

1. Stamp will be appropriately marked as follows to indicate the action taken:
 - a. Action 1 (no exception taken): Means fabrication, manufacture, or construction may proceed providing submittal complies with Contract Documents.
 - b. Action 2 (make corrections noted; no resubmission required): Means fabrication, manufacture, or construction may proceed providing submittal complies with Architect's notations and Contract Documents. (Note: If Contractor cannot comply with notations, make revisions and resubmit.)
 - c. Action 3 (make corrections noted; submit corrected copy): Means fabrication, manufacture, or construction may proceed; however, submittal did not fully demonstrate full extent of all conditions, details and coordination with other surrounding work and therefore requires additional information and rework as noted. Resubmit shop drawings for final Action 1 or 2. Should Contractor proceed with fabrication, manufacturing or construction, it shall do so at its own risk.
 - d. Action 4 (rejected, revise and resubmit): Means submittal does not comply with design intent of Contract Documents. Do not use submittals stamped Action 3. Make revisions and resubmit.
 - e. Action 5 (rejected, submit specified item): Means submittal varies from specified item or system specified in Contract Documents and is not acceptable for use on the project. Do not use submittals stamped Action 4. Make revisions and resubmit.
 - f. Action 6 (resubmit with related assembly items): Means submittal of related assembly item(s) are required in conjunction with the submittal for proper review.
 - g. Action 7 (rejected; incorrect transmittal): Means the Submittal Transmittal form specified for use on the Project was not included, incomplete, or incorrectly completed.
 - h. Action 8 (No Action): Means documents have not been reviewed by Architect and submittal is returned to Contractor for several possible reasons: submittal not requested, submittal not complete, submittal not coordinated, or submittal bears no resemblance to design intent.
 - i. Action 9 (submitted to consultant for review): This code is for the use of the Architect to indicate routing to various A/E consultants. Any submittals marked Action 6 by Architect will be returned to Contractor without review.

j. Record Submittals: Specifications require certain information and calculations be submitted for record purposes only. Such submittals will not be acted upon, stamped or returned to Contractor.

2. Do not permit submittals marked "Rejected, Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.

3. Note: Any work performed prior to receiving a fully approved submittal shall be done at the Contractor's risk and shall be subject to being replaced if Contract requirements are not met.

C. Contract Requirements:

1. Review actions by Architect and Architect's consultants shall not relieve the Contractor from compliance with requirements of the Contract Drawings and Specifications.

a. Acceptance of submittals with deviations shall not relieve Contractor from responsibility for additional costs of changes required to accommodate such deviations.

b. Deviations included in submittals without prior acceptance will be considered an exception from review of submittals whether noted or not on returned copy.

****** DELETE PARAGRAPH BELOW AND RETAIN FOLLOWING PARAGRAPH IF CAMPUS CONSTRUCTION MANAGER IS NOT INVOLVED IN PROJECT.*

2. No review action, implicit or explicit, shall be interpreted to authorize changes in the Work. Changes shall only be authorized by separate written Change Order or Field Instruction, in accordance with the Contract General Conditions.

3. When professional certification of performance criteria of materials, systems or equipment is required by Contract Documents, University Representative and Architect shall be entitled to rely upon accuracy and completeness of such calculations and certifications.

4. Notations by University Representative or Architect which increase contract cost or time of completion shall be brought to University Representative's and Architect's attention before proceeding with Work.

D. Resubmittals:

1. Subject to same terms and conditions as original submittal.

2. University Representative and Architect will accept not more than one resubmittal.

a. Should additional resubmittals be required, Contractor shall reimburse Trustees for University Representative and Architect's accounts for time spent in processing additional resubmittals at rate of 2.5 times rate of Direct Personnel Expense (DPE). Direct Personnel

Expense is defined as direct salaries of University Representative's and Architect's personnel engaged on Project and portion of costs of mandatory, and customary contributions and benefits related thereto, including employment taxes and other statutory employee benefits, insurance, sick leave, holidays, vacations, pensions, and similar contributions and benefits.

1.9 PRODUCT DATA SUBMITTALS

- A. Product Data: Catalog cuts, photographs, illustrations, standard details, standard schedules, performance charts, material characteristics, color and pattern charts, test data, roughing-in diagrams and templates, standard wiring diagrams and performance curves and listings by Code authorities and nationally-recognized testing and inspection services. Where product data must be specially prepared because standard manufacturer data is not suitable for use, submit according to requirements for shop drawings specified below.
- B. Modifications to Standard Product Data: Modify manufacturer's standard catalog data to indicate precise conditions of the Project.
 1. Provide space for review action stamps and, if required by authorities having jurisdiction, license seal of Engineer and/or design consultant, if applicable.
 2. Mark each copy to show applicable choices and options. Where manufacturer's product data includes information on several products, some of which are not required, mark copies to highlight applicable information.
 3. Include the following information:
 - a. Manufacturer's literature with recommendations,
 - b. Compliance with recognized trade association standards,
 - c. Compliance with recognized testing agency standards,
 - d. Application of testing agency labels and seals,
 - e. Notation of dimensions verified by field measurement,
 - f. Notation of coordination requirements,
 - g. Environmental Product Declaration (EPD)'s information.

Environmental Product Declaration: Independently verified document created and verified in accordance with International Organization for Standardization (ISO) 14025 for Type III environmental declarations that identifies the global warming potential emissions of the facility- specific material or product through a product stage life cycle assessment.

The legislation was introduced as Assembly Bill (AB) 262. It targets the embedded carbon emissions of certain construction materials used in public works projects. AB 262 requires that these materials have a global warming potential that falls below a limit set by the Department of General Services.

The following materials or products are subject to the Buy Clean California Act, and shall have EPD's submitted for all products listed below:

Material or product	Material specifications: CSI Unifomat
Carbon steel rebar	Section 03 20 00, "Bar Reinforcement"
Structural steel	Section 05 12 00, "Structural Steel"
Flat glass	Section 08 80 00, "Glazing"
Mineral wool board insulation	Section 07 21 13.19 "Mineral Board Insulation"

4. Do not submit product data until compliance with requirements of the Contract Documents has been confirmed.
 5. Proceed with installation only using reviewed copy of product data with appropriate action stamp as indicated in Section 1.8 B1 above. Do not permit use of unmarked copies of product data in connection with construction.
- C. Copies: Submit electronic copies of catalog pages with applicable data highlighted and cross-referenced to Drawings and Specifications requirements. Paper copies may be reproduced however, will not be acceptable replacement of an electronic submittal unless specifically authorized by the University Representative. Distribution of approved submittals shall be electronic unless otherwise noted.

1.10 SHOP DRAWINGS SUBMITTALS

- A. Shop Drawings: Drawings, diagrams, schedules and other graphic depictions to illustrate fabrication and installation of a portion of the Work. Shop Drawings shall include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:
1. Identification of products and materials included
 2. Compliance with referenced standards
 3. Notation of coordination requirements
 4. Dimensions
 5. Notation of dimensions established by field measurement.
- B. Coordination: Show all field dimensions and relationships to adjacent or critical features of Work.
- C. Preparation of Shop Drawings: Prepare and submit electronically newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of

Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

1. Provide space for review action stamps and, if required by governing authorities having jurisdiction, license seal of Architect and Architect's design consultant, if applicable.
 2. Prepare shop drawings submitted in electronic format that shall be printable on minimum sheet size of 17-inches by 22-inches, or smaller if a multiple of 8-1/2 inches by 11-inches. Maximum size shall be 30-inches by 42-inches.
 3. Except as otherwise approved by the University Representative, submit all shop drawings electronically using the Contractor's Electronic Project Management system.
 4. Do not use Shop Drawings without an appropriate final review stamp indicating action taken in connection with construction.
- D. Distribution of Reviewed Shop Drawings: Electronic distribution of reviewed shop drawings will be by Contractor and must be stamped by the Architect.

1.11 SAMPLE SUBMITTALS

- A. Samples: Full-size, fully-fabricated samples cured and finished as specified and physically identical with the material or product proposed. Samples shall include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture and pattern.
1. Mount, display, or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to include the following:
 - a. Project name and location
 - b. Manufacturer and supplier.
 - c. Name, finish, and composition of material.
 - d. Location where material is to be used.
 - e. Specification Section number.
 - f. Submittal number.
 - g. Contractor's review stamp.
 - h. Space for Architect's review stamp.
 - i. Compliance with recognized standards
 - j. Availability and delivery time.

2. Submit Samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
 3. Submit actual samples. Photographic or printed reproductions will not be accepted.
 4. Field samples specified in individual Sections are special types of samples. Field samples shall be full-size examples erected on site to illustrate finishes, coatings, or finish materials and to establish the standard by which the Work will be evaluated.
- B. Preliminary or Selection Submittals: Where samples are for selection of color, pattern, texture or similar characteristics from a range of standard choices, submit full set of choices for the specified material or product.
1. Preliminary submittals will be reviewed and returned with the Architect's mark indicating selection and other action.
- C. Quantity: Except for samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit three sets. One sample will be returned marked with the action taken.
1. Maintain sets of samples, as returned, at the Project site, for quality comparisons throughout the course of construction.
 2. Unless otherwise noted, full-size and complete samples will be returned and may be incorporated into field mock-ups. Samples may be incorporated into the Work (completed construction) only with written approval of the Architect and the University Representative in advance of sample preparation.
 3. Other samples shall be produced and mounted on cardstock in 8-1/2" by 11" format, three-hole punched and suitable for inclusion in product sample binders. Contractor shall provide binders as directed.
 4. Contractor shall prepare and distribute additional samples to subcontractors, manufacturers, fabricators, suppliers, installers, and others as necessary for performance of the Work.
 5. Accepted samples will form standard of comparison for finished Work. Defects and deviations in excess of those in accepted samples, are unacceptable and are subject to rejection of completed Work.
- D. Color Samples: Architect will review and select colors for Project only after all colors are received, so that colors may be properly coordinated.
- E. Review of Field Samples: Review by Architect of field samples will be made for the following products if not otherwise required and if requested by Contractor.

1. Casework.
2. Portland cement concrete paving: Trowel finish, imprinted texture, colors, abrasive blasting, exposed aggregate and acid washing.
3. Exterior finish assembly including all water proofing, color and texture.
4. Gypsum board textures and finishes.
5. Gypsum plaster textures and finishes.
6. Field-applied paint colors and finishes: Draw-downs and brush-outs.

1.12 MANUFACTURER'S INSTRUCTIONS

- A. Manufacturer's Instructions: Submit manufacturer's instructions for preparation, mixing, assembly, handling, application and installation of products, as applicable and as specified in product sections of the Specifications.
 1. Include applicable ICBO ES Evaluation Reports. Evaluation Reports shall be current and shall be annotated for applicable products.
 2. Include applicable Safety Data Sheets (SDS), for Project record only.
 3. Include written recommendations, as applicable, from manufacturer for Project conditions.
 4. Identify conflicts between manufacturers' instructions and Contract Documents.
- B. Copies: Electronic distribution will be required. If requested and agreed to by the University Representative, copies may be distributed as necessary.
- C. Reviews by Architect and University's Representative: Manufacturer's instructions shall be for information and will not be reviewed by Architect or University's Representative. Contractor shall be responsible for proper coordination and installation of product or material specified.

1.13 REPORTS OF RESULTS OF INSPECTIONS AND TESTS

- A. Reports of Results of Inspections and Tests: Submit technical data, test reports, calculations, surveys, and certifications based on field tests and inspections by independent inspection and testing agency and by authorities having jurisdiction.
 1. Reports of results of inspections and tests shall not be considered Contract Documents.
 2. Refer to Section 01 45 00 - Quality Control for additional requirements.

1.14 OPERATION AND MAINTENANCE DATA SUBMITTALS

- A. Operation and Maintenance Data Submittals: Refer to requirements specified in Section 01 78 23 - Operation and Maintenance Data. Include operation and maintenance data submittals in Construction Progress Schedule. Refer to Contract General Conditions.

1.15 CERTIFICATES

****** DELETE PARAGRAPH BELOW AND RETAIN FOLLOWING PARAGRAPH IF CAMPUS CONSTRUCTION MANAGER IS NOT INVOLVED IN PROJECT.*

- A. When specified in individual specification Sections, submit manufacturers' certificates to Architect through Electronic Project Management system for review as specified.

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- B. Submit in form of letter or company standard forms, signed by officer of manufacturer.

- C. Each certification shall include the following:

1. Project name and location.
2. Contractor's name and address.
3. Quantity and date or dates of shipment or delivery to which certificate applies.
4. Manufacturer's name.

- D. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

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- E. Certificates may be recent or previous test results on material or product, but must be acceptable to University Representative and Architect.

****** DELETE PARAGRAPH BELOW AND RETAIN PREVIOUS PARAGRAPH IF CAMPUS CONSTRUCTION MANAGER IS INVOLVED IN PROJECT.*

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

Not applicable to this Section.

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SECTION 01 34 00

REQUESTS FOR INTERPRETATION (RFI)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Procedures for submitting requests for interpretation (RFI).
- B. Limitations on use of RFI to obtain interpretation and clarification.

1.3 RELATED SECTIONS

- A. Section 01 31 00 - Coordination: Requirements for organizing and coordinating the Work.
- B. Section 01 33 00 - Submittals Procedures: Restriction on use of submittals for changes in materials, products, equipment and systems.
- C. Section 01 63 00 - Product Substitution Procedures: Procedures for requesting substitutions of materials, products, equipment and systems.

1.4 DEFINITIONS

- A. Request for Interpretation: A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as an RFI.

1.6 CONTRACTOR'S REQUESTS FOR INTERPRETATION (RFIs) POST AWARD

- A. Contractor's Requests for Interpretation (RFIs): Should Contractor be unable to determine from the Contract Documents the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of Work is described differently at more than one place in the Contract Documents; the Contractor shall request that the Architect make an interpretation of the requirements of the Contract Documents to resolve such matters. Contractor shall comply with procedures specified herein to make Requests for Interpretation (RFIs).
- B. Submission of RFIs: RFIs shall be prepared and submitted electronically utilizing the Electronic Project Management System. Refer to specification section 01 32 00.
 - 1. Forms shall be completely filled in, and if supplemental drawings or other information is prepared by hand, it shall be fully legible.
 - 2. Each RFI shall be given a discrete, consecutive number. Revised RFI shall include the original number with the addition of a decimal and subsequent revision number. For instance, Revision #1 to RFI 029 should be noted as RFI 029.1.
 - 3. Each page of the RFI and each attachments to the RFI shall bear the University's project name, project number, date, RFI number and a descriptive title.

4. Contractor shall attest to good faith effort to determine from the Contract Documents the information requested for interpretation. Frivolous RFI or simply passing on the RFI to the University without first vetting the RFI shall be subject to reimbursement from Contractor to University for fees charged by University, the Architect, Architect's consultants and other design professionals engaged by the University.
- C. Subcontractor-Initiated and Supplier-Initiated RFIs: RFIs from subcontractors and material suppliers shall be submitted through, be reviewed by and be attached to an RFI prepared, signed and submitted by Contractor. RFIs submitted directly by subcontractors or material suppliers will be returned unanswered to the Contractor.
1. Contractor shall review all subcontractor- and supplier-initiated RFIs and take actions to resolve issues of coordination, sequencing and layout of the Work. Coordination of the work, sequence and layout are not the responsibility of the University or Architect.
 2. RFIs submitted to request clarification of issues related to means, methods, techniques and sequences of construction or for establishing trade jurisdictions and scopes of subcontracts will be returned without interpretation. Such issues are solely the Contractor's responsibility.
 3. Contractor shall be responsible for delays resulting from the necessity to resubmit an RFI due to insufficient or incorrect information presented in the RFI.
- D. Requested Information: Contractor shall carefully study the Contract Documents, in particular, Article 5 of the Contract General Conditions, to ensure that information sufficient for interpretation of requirements of the Contract Documents is not included. RFIs that request interpretation of requirements clearly indicated in the Contract Documents will be returned without interpretation.
1. In all cases in which RFIs are issued to request clarification of issues related to means, methods, techniques and sequences of construction, for example, pipe and duct routing, clearances, specific locations of Work shown diagrammatically, apparent interferences and similar items, the Contractor shall furnish all information required for the Architect or University's Representative to analyze and/or understand the circumstances causing the RFI and prepare a clarification or direction as to how the Contractor shall proceed.
 2. If information included with this type RFI by the Contractor is insufficient, the RFI will be returned unanswered.
- E. Unacceptable Uses for RFIs: RFIs shall not be used to request the following:
1. Approval of submittals (use procedure specified in Section 01 33 00 - Submittals Procedures)
 2. Approval of substitutions (refer to Section 01 63 00 - Product Substitution Procedures)
 3. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Contract General Conditions, as discussed in detail during pre-construction meeting)
 4. Different methods of performing Work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Contract General Conditions).
- F. Disputed Requirements: In the event the Contractor believes that a clarification by the University's Representative results in additional cost or time, Contractor shall comply with Article 5 of the Contract General Conditions.
- G. RFI Log: The Electronic Project Management System will maintain a log of RFIs. Only the University may close any outstanding RFI.
- H. Review Time: Architect will return RFIs to Contractor and University's Representative within seven calendar days of receipt. RFIs received after 12:00 noon shall be considered received on the next regular working day for the purpose of establishing the start of the seven-calendar day response period. Additional time shall be granted depending on the complexity of the request.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

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SECTION 01 35 00 - SPECIAL PROCEEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

1. Environmental protection procedures
2. Smoke/odor control procedures
3. Noise control procedures
4. Dust and air pollution control procedures
5. Hazardous materials procedures
6. Welding and burning mitigation procedures
7. Erosion and sediment control procedures (Storm Water Pollution Protection Plan)
8. Disposal operations procedures
9. Cultural resources procedures
10. Alteration project procedures.

1.3 RELATED SECTIONS

- A. Section 01 73 29 - Cutting and Patching: General requirements for procedures and limitations for cutting and patching the work.

1.4 SUBMITTALS

- A. Refer to Section 01 33 00 – Submittal Procedures
- B. Environmental Protection Plan – Submit within 30 days of commencement in Notice to Proceed.
- C. State Water Pollution Prevention Plan (SWPPP): Submit Notice of Intent to the Regional Water Quality Control Board (RWQCB) with copies to Trustees Representative and Campus Environmental Health and Safety.
- D. Submit notification in writing to the San Luis Obispo County Air Pollution Control District (SLOAPCD) with a copy to the Trustees Representative, 10 days prior to the start of Demolition.

- E. Submit notification in writing to the San Luis Obispo County Air Pollution Control District (SLOAPCD) with a copy to the Trustee's Representative, 14 days prior to the start of road construction.

1.5 ENVIRONMENTAL PROTECTION PROCEDURES

- A. Environmental Protection Procedures, General: Requirements specified in this Section are in addition to those of Article 4.03 of the Contract General Conditions.
 - 1. During the progress of the work, keep the premises in a neat and clean condition and protect the environment from potentially polluting construction activities both on site and off site, throughout and upon completion of the construction project.
 - 2. In coordination with the Campus, develop an Environmental Protection Plan in detail and submit to University's Representative for approval within 30 calendar days from the date of commencement specified in the Notice to Proceed. Distribute approved plan to all employees and to all subcontractors and their employees. Environmental Protection Plan shall include, but not be limited to, the following items:
 - a. Copies of required permits
 - b. Proposed sanitary landfill site
 - c. Other proposed disposal sites
 - d. Noise Control
 - e. Dust Control
 - f. Erosion and Sediment Control
 - g. Copies of any agreements with public or private landowners regarding equipment, materials storage, borrow sites, fill sites, or disposal sites. Such agreements made by Contractor shall be invalid if their execution causes violation of local or regional grading or land use regulations.
- B. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects may result.
 - 1. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize disruptions to the general public, staff and students near the site.
 - 2. Comply with noise control requirements specified below.
- C. Construction Operations: All construction operations shall comply with all applicable Federal, State and local Codes, ordinances, statutes and regulations pertaining to water, air, solid waste and noise pollution. It shall be Contractor's responsibility to identify and determine necessary measures to be taken to comply with such Codes, ordinances, statutes and regulations.
- D. Definitions of Contaminants:
 - 1. Sediment: Soil and other debris that have been eroded and transported by runoff water

2. Solid waste: Rubbish, debris, garbage and other discarded solid materials resulting from construction activities, including a variety of combustible and non-combustible wastes, such as ashes, waste materials that result from construction or maintenance and repair work, leaves and tree trimmings
 3. Chemical waste: Includes petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, disinfectants, organic chemicals and inorganic wastes. Some of the above may be classified as "hazardous"
 4. Sanitary wastes:
 - a. Sewage: Domestic sanitary sewage
 - b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing and consumption of food.
- E. Hazardous Materials: See also Section below titled "HAZARDOUS MATERIALS PROCEDURES."
1. Except as otherwise specified, in the event the Contractor encounters on the site material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead containing/based paint or other hazardous materials which have not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Trustees in writing.
 2. Work in affected areas shall not thereafter be resumed except by written agreement of the Trustees and Contractor if in fact the material is asbestos, PCB, lead containing/based paint or other hazardous materials and has not been rendered harmless.
 3. Work in affected areas shall be resumed in the absence of asbestos, PCB, lead containing/based paint or other hazardous materials, or when such materials have been rendered harmless.
- F. Protection of Natural Resources: It is intended that the natural resources within the Project boundaries and outside the limits of permanent work performed under this Contract be preserved in their existing condition or be restored to an equivalent or improved condition upon completion of the work. Confine construction activities to areas defined by the public roads, easements, and work area limits shown on the drawings. Return construction areas to their pre-construction elevations except where surface elevations are otherwise noted to be changed. Maintain natural drainage patterns. Conduct construction activities such that ponding of stagnant water conducive to mosquito breeding habitat will not occur at any time.
1. Land resources protection: Do not remove, cut, deface, injure or destroy trees or shrubs outside the work area limits. Do not remove, deface, injure or destroy trees within the Project area without permission from University's Representative. Such improvements shall be removed and replaced, if required, by the Contractor at no change in Contract Time and Contract Sum.
 2. Landscaping protection: Protect trees that are located near the limits of Project area which may possibly be defaced, bruised or injured or otherwise damaged by the Contractor's operations. No ropes, cables or guys shall be fastened to or be attached to any existing nearby trees or shrubs for anchorages. Refer to additional requirements specified in Section 01 56 00 - Temporary Barriers and Controls.
 - a. Trimming: Refer to Section 01 56 69 - Tree and Plant Protection.
 - b. Excavations around trees: Refer to Section 01 56 69 - Tree and Plant Protection.

- c. Repair and restoration: Repair or replace trees or other landscape feature scarred or damaged by equipment or construction operations as specified below. Repair and restoration plan shall be reviewed and approved by University's Representative prior to its initiation.
3. Temporary construction:
 - a. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, or any other vestiges of construction as directed by the University's Representative.
 - b. Level all temporary roads, parking areas and any other areas that have become compacted or shaped.
 - c. Unpaved areas where vehicles have been operated shall receive suitable surface treatment or shall be periodically wetted down to prevent construction operations from producing dust damage and nuisance to persons and property, at no additional cost to the Trustees.
 - d. Keep haul roads clear at all times of any object that creates an unsafe condition. Promptly remove any contaminants or construction materials dropped from construction vehicles. Do not drop mud and debris from construction equipment on public streets. Sweep clean turning areas and pavement entrances as necessary.
4. Water resources: Comply with all applicable Federal, State and local Codes, ordinances, statutes and regulations pertaining to discharge (directly or indirectly) of pollutants to underground and natural waters.
 - a. Perform all Work under the Contract in a manner that any adverse environmental impacts are reduced to a level that is acceptable to University's Representative and authorities having jurisdiction.
 - b. Refer to Division 02 - Site Construction, earthwork Sections, and Civil Drawings for specific requirements on control of Stormwater and disposal of water from dewatering activities.
5. Oily Substances: At all times, special measures shall be taken to prevent oily or other hazardous substances from entering the ground, drainage areas or local bodies of water in such quantities as to affect normal use, aesthetics or produce a measurable impact upon the areas. All soil or water that is contaminated with oily substances due to Contractor's operations shall be disposed of in accordance with applicable regulations, at no change in Contract Time and Contract Sum.

1.6 SMOKE/ODOR CONTROL PROCEDURES

- G. Smoke/Odor Control: Protect primary fresh air intakes to existing buildings from exhaust from internal combustion engines, paint and solvent fumes and other noxious fumes and vapors.
 1. Implement control methods such as snorkels from engine exhaust to within 50 feet from existing building air intakes. Provide carbon filters on air intakes as necessary, including periodic replacement of filters to ensure effectiveness.
 2. All other activities generating fumes shall be limited to minimum distance of 50 feet from air intake grilles.
 3. If fume-generating procedures must occur within 50 feet of an air intake, Contractor shall do the following:
 - a. Notify University's Representative at least 14 calendar days in advance of such activities.

- b. Perform Work when it least impacts the University (evenings, weekends or particularly windy days).
- c. Provide carbon filter media, plastic barriers, or other control methods to ensure fresh air only enters into the building ventilation system.

1.7 NOISE CONTROL PROCEDURES

- A. Noise Control Procedures, General: Requirements of this Section are in addition to those of Article 4.03 of the Contract General Conditions. Maximum noise levels within 1,000 feet of classrooms, laboratories, residences, businesses, adjacent buildings and other populated areas:
 1. Noise levels for trenchers, pavers, graders and trucks: Not exceeding 90 dBA at 50 feet as measured under noisiest operating conditions.
 2. Noise levels for all other equipment: Not exceeding 85 dBA at 50 feet.
- B. Noise Control of Equipment:
 1. Equip jackhammers with exhaust mufflers and steel muffling sleeves.
 2. Use air compressors of a quiet type such as a "whisperized" compressor. Compressor hoods shall be closed while equipment is in operation.
 3. Use electrically-powered rather than gasoline or diesel powered fork-lifts where feasible.
 4. Provide portable noise barriers around jack hammering, with barriers constructed of 3/4 inch plywood lined with 1-inch thick ductliner type fiberglass on Work side.
- C. Noise Control of Construction Operations:
 1. Keep noisy equipment as far as possible from noise-sensitive site boundaries.
 2. Machines shall not be left idling.
 3. Use electric power in lieu of internal combustion engine power whenever possible.
 4. Maintain equipment properly to reduce noise from excessive vibration, faulty mufflers, or other sources. All engines shall have properly functioning mufflers.
- D. Scheduling of Noisy Operations: Schedule construction activities to minimize time of noisy operations and disruption to occupants of adjoining facilities. Notify University's Representative in advance of performing Work creating unusual noise and schedule such Work at times mutually agreeable.
- E. Accessory Noise: Do not play radios, tape recorders, televisions, and other similar items at construction site.

1.8 DUST AND AIR POLLUTION CONTROL PROCEDURES

- A. Dust and Air Pollution Control Procedures, General: Requirements of this Section are in addition to those of Article 4.03 of the Contract General Conditions. Employ measures to prevent or minimize creation of dust and air pollution. Contractor shall appoint a dust control monitor to oversee and implement all measures specified in this Article.
1. Unpaved areas shall be wetted down, to eliminate dust formation, a minimum of twice a day to reduce particulate matter. When wind velocity exceeds 15 mph, site shall be watered down more frequently.
 2. Store all volatile liquids, including fuels or solvents in closed containers.
 3. No on-site burning of debris, lumber and other scrap shall be permitted.
 4. Properly maintain equipment to reduce gaseous pollutant emissions.
 5. Exposed areas, new driveways and sidewalks shall be seeded, treated with soil binders or paved, as appropriate, as soon as possible.
 6. Cover stockpiles of soil, sand and other loose materials if not currently being utilized and the the end of each work day.
 7. Cover trucks hauling soil, debris, sand or other loose materials.
 8. Sweep project area streets and walks at least once weekly or as needed to maintain a clean road or walkway. Refer to Section 01 74 00 - Cleaning Requirements.

1.9 HAZARDOUS MATERIALS PROCEDURES

- A. Identified Hazardous Materials:
1. This is a new construction project and existing materials are not anticipated.
- B. Unidentified Hazardous Materials:
1. Information regarding known asbestos containing material (ACM) is available from University's office of Environmental Health & Safety. Contact the University's Representative to request this information.
 2. Except as otherwise specified, in the event that Contractor encounters on the project site material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead containing/based paint or other hazardous materials which have not been rendered harmless, the Contractor shall immediately stop work in the area affected and report the condition to University's Representative.
 3. Work in the affected area shall not be resumed except by written agreement between University and Contractor if in fact the material is asbestos, PCB, or other hazardous materials and has not been rendered harmless.

4. Work in the affected area shall be resumed in the absence of asbestos, PCB lead containing/based paint or other hazardous materials, or when such materials have been rendered harmless.
- C. Notification and Disclosure: Refer to Contract General Conditions for Asbestos Notification and Disclosure requirements.
1. In the event that hazardous materials are discovered on site during performance of the Work, Contractor shall notify the University's Representative and request directions for abatement of hazardous materials.
 2. University will ensure that the identified hazardous waste and/or hazardous materials are handled and disposed in the manner specified by the State of California Hazardous Substances Control Law (Health and Safety Code Division 20, Chapter 6.5).

1.10 WELDING AND BURNING MITIGATION PROCEDURES

- A. Welding and Burning Mitigation Procedures: Eliminate welding and burning of steel as much as possible. Where unavoidable, perform welding and burning with all possible precaution to avoid fire hazard. Provide a fire watch for minimum of 30 minutes after burning stops. Provide adequate protection for all adjacent surfaces.
- B. Hot work permit issued by the University is required for all activity where sparks, heat or flame are used which pose a threat to start a fire.

1.11 EROSION AND SEDIMENT CONTROL PROCEDURES

- A. Erosion and Sediment Control Procedures: Refer to runoff control requirements specified in Section 01 57 00 - Temporary Controls. Obtain and comply with Storm Water Pollution Protection Plan (SWPPP) and project-specific requirements indicated on Civil Drawings and Specifications.

1.12 DISPOSAL OPERATIONS PROCEDURES

- A. Solid Waste Management:
1. Supply solid waste transfer containers. Daily remove all debris such as spent air filters, oil cartridges, cans, bottles, combustibles and litter. Take care to prevent trash and papers from blowing off of the construction site. Encourage personnel to use refuse containers. Convey contents to a sanitary landfill.
 2. Washing of concrete containers where wastewater may reach adjacent property, storm drains or natural water courses will not be permitted. Remove any excess concrete to the sanitary landfill.
- B. Chemical Waste and Hazardous Materials Management: furnish containers for storage of spent chemicals used during construction operations. Dispose of chemicals and hazardous materials in accordance with applicable regulations.
- C. Garbage: Store garbage in covered containers, pick up as required and dispose of properly.

- D. Grading Spoil and Landscape Debris: Dispose of vegetation, weeds, rubble, and other materials removed by the clearing, stripping and grubbing operations off site at a suitable disposal site in accordance with applicable Federal, State and local Codes, ordinances, statutes and regulations
- E. Excavated Materials:
 - 1. Native soil complying with the requirements of applicable Division 2 - Site Construction earthwork Section, may be used for backfill, fill and embankments as allowed in applicable by that section.
 - 2. Remove all material which is excavated in excess of that required for backfill. Dispose of unsuitable excavated material from the site and dispose of it legally.
 - a. Excess suitable backfill material shall be hauled off site. No additional compensation will be paid to the Contractor for such off haul. Include all such costs in the Contract Sum.
 - b. Unsuitable backfill material shall be disposed of off-site in accordance with applicable regulations, in a disposal site indicated in the Environmental Protection Plan.
 - c. Remove rubbish and materials unsuitable for backfill immediately following excavation.
 - d. Remove material in excess of that required for backfill immediately following backfill operations.

1.13 CULTURAL RESOURCES PROCEDURES

- A. Cultural Resources Procedures: Requirements specified in this Section are in addition to those required by Article 4.03 of the Contract General Conditions.
 - 1. Project does not pass through any known archaeological sites. However, it is conceivable that unrecorded archaeological sites could be discovered during construction.
 - 2. In the event that artifacts, human remains, or other cultural resources are discovered during subsurface excavations at locations of the Work, the Contractor shall protect the discovered items, cease work for a distance of 35 feet radius in the area, notify the Architect and University Representative and comply with applicable law.
 - 3. Trustees may retain an Archaeologist to monitor and recover data and artifacts during period that work has ceased.
 - 4. All items found which are considered to have archaeological significance are the property of the University.

1.14 ALTERATION PROJECT PROCEDURES

- A. Coordinate the work of trades and schedule elements of alterations and renovation work by procedures and methods to expedite completion of the work.
- B. In addition to demolition specifically shown, cut, move or remove items as necessary to provide access or to allow alterations and new work to proceed. Include such items as:
 - 1. Repair or removal of hazardous or unsanitary conditions.

2. Removal of abandoned items and items serving no useful purpose, such as abandoned piping, conduit and wiring.
 3. Removal of unsuitable or extraneous materials not marked for salvage, such as abandoned furnishings and equipment, and debris such as rotted wood, rusted metals and deteriorated concrete.
 4. Cleaning of surfaces, and removal of surface finishes as needed to install new work and finishes.
- C. Patch, repair and refinish existing items to remain, to the specified condition for each material, with a smooth and clean transition to adjacent new items of construction.
- D. Assign the work of moving, removal, cutting and patching, to trades qualified to perform the work in a manner to minimize the possibility of damage to each type of work, and provide means of returning surfaces to appearance of new work.
- E. Perform cutting and removal work with minimal disruption and in a manner to avoid damage to adjacent work.
- F. Cut finish surfaces such as masonry, tile, plaster or metals, using methods that terminate surfaces in a straight line at a natural point of division.
- G. Perform cutting and patching as specified in Section 01 73 29 - Cutting and Patching.
- H. Protect existing finishes, equipment, and adjacent construction that is scheduled to remain, from damage.
1. Protect existing and new work from weather and extremes of temperature.
 2. Maintain existing interior work above 60 degrees F or at a temperature recommended by any product manufacture.
 3. Provide weather protection, waterproofing, heat and humidity control as needed to prevent damage to remaining work and to new work.

1.15 RULES FOR PERFORMING ELECTRICAL WORK ON CAMPUS

- A. To ensure the safety of personnel working on electrical systems, it is critical that safe work practices are followed and that outages are well planned and carefully scheduled and coordinated. The following rules apply to contractors performing electrical work on the University campus:
1. Electrical work shall not be performed on energized systems.
 2. Panel covers and dead fronts shall not be removed while a panel is energized.
 3. Circuit breakers shall not be cycled to switch existing loads on and off while a panel is in service.

4. All work up to the point of connection at an existing panel shall be completed without penetrating the enclosure. Once this new work is complete up to the existing panel, an outage shall be scheduled to facilitate termination at the panel.
5. Contractors shall schedule electrical outages with the responsible University Representative. Work shall be planned and scheduled so as to minimize the number of outages required.
6. The University Electricians will de-energize systems at the point of connection on the scheduled outage day and time. Lock Out/Tag Out will be performed by both the University Electricians and the qualified contractor performing the work.
7. During an outage, the individual working on the system shall be responsible for confirming that an "**electrically safe work condition**" has been established per NFPA 70E procedures using appropriate PPE.
8. Once the work at the point of connection is complete an inspection shall be scheduled with the campus building inspector and/or University Electricians.
9. Upon acceptance of the inspection, the locks shall be removed and the system shall be re-energized by the University Electricians.
10. Upon re-energization, the contractor shall test all new installations to confirm they are functioning properly prior to completing work and leaving the work location.

PART 2 - PRODUCTS

2.1 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

- A. Provide same products or types of construction as that in existing structure, as needed to patch, extend or match existing.
- B. Generally the Contract Documents will not define products or standards of workmanship present in existing construction; determine products by inspection and necessary testing, and determine quality of workmanship by using existing as a sample for comparison.
- C. The presence of a product, finish, or type of construction requires that patching, extending or matching shall be performed as necessary to make work complete and consistent with identical standards of quality.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

- A. Perform cutting and patching as specified in Section 01 73 29 - Cutting and Patching.

END OF SECTION 01 35 00

SECTION 01 35 05
SAFETY AND HEALTH PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Procedures for health and safety protection and requirements for reporting accidents.

1.3 RELATED SECTIONS

- A. Section 01 35 01 - Hazardous Material Procedures: Protection from asbestos containing materials (ACM), polychlorinated biphenyl (PCB), lead containing paint or other hazardous materials.
- B. Section 01 56 00 - Temporary Barriers and Enclosures: Protective barriers.

1.4 SUBMITTALS

- A. Accident Reporting: A copy of each accident report, which the Contractor or subcontractors submit to their insurance carriers, shall be forwarded to the Architect and to the Trustees' Representative as soon as possible, but in no event later than seven (7) calendar days after the day the accident occurred.
- B. Other Submittals: If agreed to in writing at the preconstruction safety meeting, other submittals shall be required. One such submittal that may be included is a plan of action for handling hazardous materials to contain the following:
 - 1. Number, type, and experience of employees to be used for the Work
 - 2. Description of how safety and health regulations and standards shall be met
 - 3. Type of protective equipment and work procedures to be used
 - 4. Emergency procedures for accidental spills or exposures.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Special facilities, devices, equipment, clothing, and similar items used by the Contractor in the execution of the Work shall comply with all applicable regulations. The contractor is responsible for insuring a safe work environment for its employees, its subcontractors as well as University representatives, for the full duration of the work.

PART 3 - EXECUTION

3.1 STOP WORK ORDERS

- A. Stop Work Orders:
1. When the Contractor or its subcontractors are notified by the University's Representative of an incident of noncompliance with the provisions of the Contract, and the action(s) to be taken, the Contractor shall immediately, or within 48 hours after receipt of a notice of violation, correct the unsafe or unhealthy condition to prevent harm.
 2. If the Contractor fails to comply promptly, all or any part of the work performed may be stopped by with a "Stop Work Order." When, in the opinion of the University's Representative, satisfactory corrective action has been taken to correct the unsafe and unhealthy condition, a start order will be given immediately.
 3. The Contractor shall not be allowed any extension of time or compensation for damages by reason of or in connection with such work stoppage.

3.2 PROTECTION

- A. Protection: Contractor shall take all necessary precautions to prevent injury to the public, building occupants, or damage to property of others.
1. For the purposes of the Contract, the public or building occupants shall include all persons not employed by the Contractor or a subcontractor working under the Contractor's direction.
 2. Work shall not be performed in any area occupied by the public or Owner's employees unless specifically permitted by the Contract or the Owner and unless adequate steps are taken for the protection of the public and the Owner's employees.
 3. Whenever practicable, the work area shall be fenced, barricaded, or otherwise blocked off from the public or building occupants to prevent unauthorized entry into the work area.
- B. Alternate Precautions: When the nature of the Work prevents isolation of the work area, and the public or building occupants may be in or pass through, under or over the work area, alternate precautions such as the posting of signs, the use of signal persons, the erection of barricades or similar protection around particularly hazardous operations shall be used as appropriate.
- C. Public Thoroughfare: When Work is to be performed over a public thoroughfare such as a sidewalk, lobby, or corridor, the thoroughfare shall be closed, if possible, or other precautions taken such as the installation of screens or barricades. When the exposure to heavy falling objects exists, as during the erection of building walls or during demolition, special protection of the type detailed in 29 CFR 1910/1926 shall be provided.
- D. Hazardous Conditions: Storing, positioning or use of equipment, tools, materials, scraps, and trash in a manner likely to present a hazard to the public or building occupants by its accidental shifting, ignition, or other hazardous qualities is prohibited.

END OF SECTION

SECTION 01 35 53

SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Contractor Security requirements.

1.3 SECURITY (Also refer to Contract General Conditions)

- A. Protect the Work from theft, vandalism and unauthorized entry. Contractor shall have sole responsibility for job site security.
- B. Maintain security throughout construction until the University's occupancy or acceptance.
- C. Provide keying different from permanent keying of locks and include organized, locked and supervised storage for receiving and dispensing items of finish hardware throughout the construction.
- D. Provide the Project Inspector with keys necessary to gain access to locked areas of the Work. The Project Inspector will be responsible for such keys and will return them to the Contractor upon acceptance of the project or area as complete.

1.4 ENTRY CONTROL

- A. Restrict entrance of persons and vehicles into project site.
- B. Allow building entrance only to authorized persons with proper identification.

1.5 PERMANENT KEYS

- A. Immediately upon receipt of permanent keys for whatever purpose (finish hardware, mechanical equipment, casework, dispensers, lockers, switches, equipment items, etc.), tag or otherwise clearly identify keys according to one approved system and turn them over to the University prior to any opportunity of access to keys by parties other than the University.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 41 00 - REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 AUTHORITY AND PRECEDENCE OF CODES, ORDINANCES AND STANDARDS

- A. Authority: All codes, ordinances and standards referenced in the Drawings and Specifications shall have the full force and effect as though printed in their entirety in the Specifications.
- B. Precedence:
 - 1. Where specified requirements differ from the requirements of applicable codes, ordinances and standards, the more stringent requirements shall take precedence.
 - 2. Where the Drawings or Specifications require or describe products or execution of better quality, higher standard or greater size than required by applicable codes, ordinances and standards, the Drawings and Specifications shall take precedence so long as such increase is legal.
 - 3. Where no requirements are identified in the Drawings or Specifications, comply with all requirements of applicable codes, ordinances and standards of authorities having jurisdiction.

1.3 APPLICABLE CODES, LAWS AND ORDINANCES

- A. Applicable Codes, Laws and Ordinances: Refer also to Section 01 11 00 - Summary of the Work regarding permits and licenses.
 - 1. Performance of the Work shall meet or exceed the minimum requirements of the current California Code of Regulations (CCR), Title 24, including but not limited to the following:
 - a. Building Standards Administrative Code, Part 1, Title 24 C.C.R.
 - b. California Building Code, Vol. 1 & 2 (CBC), Part 2, Title 24 C.C.R. (2012 International Building Code, as amended by California)
 - c. California Electrical Code (CEC), part 3, title 24 C.C.R. (2011 National Electrical Code, as amended by California)
 - d. California Mechanical Code (CMC), Part 4, Title 24 C.C.R. (2012 Uniform Mechanical Code, as amended by California)
 - e. California Plumbing Code (CPC), Part 5, Title 24 C.C.R. (2012 Uniform Plumbing Code, as amended by California)
 - f. California Energy Code, Part 6, Title 24 C.C.R.
 - g. California Fire Code (CFC), Part 9, Title 24 C.C.R. (2012 International Fire Code, as amended by California)
 - h. California Referenced Standards, Part 12, Title 24 C.C.R. (partial list, see CBC chapter 35 & CFC Chapter 45)

- i. NFPA 13 Sprinkler Systems (CA amended)
 - j. NFPA 14 Standpipe & Hose (CA Amended)
 - k. NFPA 17 Dry Chemical Systems
 - l. NFPA 17a Wet Chemical Systems
 - m. NFPA 20 Pumps for Fire Protection
 - n. NFPA 24 Fire Service Mains and The Appurtenances
 - o. NFPA 72 National Fire Alarm Code (California Amended)
 - p. NFPA 253 Critical Radiant Flux of Floor Covering Systems
 - q. NFPA 2001 Clean Agent Fire Extinguishing Systems,
 - r. Reference Code Section for NFPA Standards- CBC (SFM) Chapter 35
2. Performance of the Work shall also comply with applicable requirements of California Code of Regulations (CCR) as follows:
- a. Title 19 - Public Safety
 - b. Title 22 - Social Security
3. Performance of the Work shall comply with applicable requirements of the Code of Federal Regulations (CFR) as follows:

40 CFR 61.145 - National Emission Standard for Asbestos, Standard for Demolition and Renovation

Work shall specifically conform to the applicable sections. This standard includes specific inspection, notification, work practice, training qualifications, and disposal requirements for applicable work. These requirements are enforced by the San Luis Obispo County Air Pollution Control District (SLOAPCD).

4. References on the Drawings or in the Specifications to "code", "Code" or "building code" similar terms, not otherwise identified, shall mean the codes specified above, together with all additions, amendments, changes, and interpretations adopted by code authorities of the jurisdiction having authority over the Project.
 5. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authority having jurisdiction and shall include all modifications and additions adopted by that authority. The applicable date of laws and ordinances shall be that of the date of performance of the Work.
- B. Other Applicable Laws, Ordinances and Regulations:
1. Work shall be accomplished in conformance with all applicable laws, ordinances, rules and regulations of Federal, State, County, City and special district agencies and jurisdictions having authority over the Project.
 2. Performance of the Work shall be accomplished in conformance with all rules and regulations of public utilities, utility districts and other agencies serving the facility.
 3. Where such laws, ordinances, rules and regulations require more care or greater time to accomplish Work, or require better quality, higher standards or greater size of products, Work

shall be accomplished in conformance to such requirements with no change to the Contract Time and Contract Sum, except where changes in laws, ordinances, rules and regulations occur subsequent to the execution date of the Agreement.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

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SECTION 01 42 00 - REFERENCE STANDARDS AND ABBREVIATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Use of references in Drawings and Specifications, including requirements for copies of reference standards at Project site.
- B. Definitions of terms used in Specifications and Drawings, including abbreviations, acronyms, names and terms which may be used in Specifications.

1.3 RELATED SECTIONS

- A. Section 01 41 00 - Regulatory Requirements: Identification of applicable building Code and other codes, ordinances and regulations applicable to performance of the Work.

1.4 USE OF REFERENCES

- A. References: The Drawings and Specifications contain references to various standards, standard specifications, codes, practices and requirements for products, execution, tests and inspections. These reference standards are published and issued by the agencies, associations, organizations and societies listed in this Section or identified in individual product specification Sections.
 - 1. Wherever term "Agency" occurs in Standard Specifications, it shall be understood to mean the term used for University for purposes of the Contract.
 - 2. Wherever term "Engineer" occurs in Standard Specifications, it shall be understood to mean Architect or other responsible design professional for purposes of the Contract.
 - 3. Where reference is made to Standard Details, such reference shall be to the Standard Details accompanying the Standard Specifications.
- B. Relationship to Drawings and Specifications: Such references are incorporated into and made a part of the Drawings and Specifications to the extent applicable.
- C. Referenced Grades Classes and Types: Where an alternative or optional grade, class or type of product or execution is included in a reference but is not identified on the Drawings or in the Specifications, provide the highest, best and greatest of the alternatives or options for the intended use and prevailing conditions.
- D. Copies of Reference Standards:

1. Reference standards are not furnished with the Drawings and Specifications because it is presumed that the Contractor, subcontractors, manufacturers, suppliers, trades and crafts are familiar with these generally-recognized standards of the construction industry.
2. Copies of reference standards may be obtained from publishing sources.

E. Jobsite Copies:

1. Contractor shall upon request, obtain and maintain at the Project site copies of reference standards identified on the Drawings and in the Specifications in order to properly execute the Work.
2. At a minimum, the following shall be readily available at the site, as applicable to the Work:
 - a. State Building Codes: As referenced in Section 01 41 00 - Regulatory Requirements.
 - b. Safety Codes: Occupational Safety and Health Act (OSHA) regulations and State of California, California Administrative Code, California Code of Regulations (CCR), Title 8 - Industrial Relations, Chapter 4, Subchapter 7, General Industry Safety Orders (Cal-OSHA), to extent applicable to the Work.
 - c. General Standards:
 - 1) CCR Title 24, Part 2, Volume 3: Current edition California Building Code (CBC) Material, Testing and Installation Standards.
 - 2) CCR Title 24, Part 12: California Referenced Standards Code, current edition.
 - 3) Underwriters Laboratories, Inc. (UL) Building Products Listing.
 - 4) Factory Mutual Research Organization (FM) Approval Guide.
 - 5) American Society for Testing and Materials (ASTM) Standards in Building Codes.
 - 6) American National Standards Institute (ANSI) standards.
 - d. Fire and Life Safety Standards: All referenced standards pertaining to fire rated construction and exiting.
 - e. Common Materials Standards: American Concrete Institute (ACI), American Institute of Steel Construction (AISC), American Welding Society (AWS), Gypsum Association (GA), National Fire Protection Association (NFPA), Tile Council of America (TCA) and Woodwork Institute of California (WIC) standards to the extent referenced within the Contract Specifications.
 - f. Research Reports: ICC Evaluation Service, Inc. (ICC-ES), formerly ICBO Evaluation Service, Inc. (ICBO ES) Research Reports and National Evaluation Service, Inc. Reports (NER), for products not in conformance to prescribed requirements stated in California Building Code (CBC).
 - g. Product Listings: Approval documentation, indicating approval of authorities having jurisdiction for use of product within the applicable jurisdiction.

F. Edition Date of References:

1. When an edition or effective date of a reference is not given, it shall be understood to be the current edition or latest revision published as of the date of the Agreement, Contract Drawings and Contract Specifications.
2. All amendments, changes, errata and supplements as of the effective date shall be included.

- G. ASTM and ANSI References: Specifications and Standards of the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI) are identified in the Drawings and Specifications by abbreviation and number only and may not be further identified by title, date, revision or amendment. It is presumed that the Contractor is familiar with and has access to these nationally- and industry-recognized specifications and standards.

1.5 DEFINITIONS OF TERMS

- A. Basic Contract Definitions: Words and terms governing the Work are defined in the Contract General and Supplementary Conditions, as referenced in the Agreement.
- B. Words and Terms Used on Drawings and in Specifications: Additional words and terms may be used in the Drawings and Specifications and are defined as follows:
 - 1. "Applicable:" As appropriate for the particular condition, circumstance or situation.
 - 2. "Approve(d):" Approval action shall be limited to the duties and responsibilities of the party giving approval, as stated in the Conditions of the Contract. Approvals shall be valid only if obtained in writing and shall not apply to matters regarding the means, methods, techniques, sequences and procedures of construction. Approval shall not relieve the Contractor from responsibility to fulfill Contract requirements.
 - 3. "And/or:" If used, shall mean that either or both of the items so joined are required.
 - 4. "Directed:" Limited to duties and responsibilities of the University's Representative or Architect as stated in the Contract General Conditions, meaning "as instructed by the University's Representative or Architect, in writing, regarding matters other than the means, methods, techniques, sequences and procedures of construction. Terms such as "directed", "requested", "authorized", "selected", "approved", "required", and "permitted" mean "directed by the University's Representative or Architect", "requested by the University's Representative or Architect", and similar phrases. No implied meaning shall be interpreted to extend the responsibility of the University's Representative, Architect or other responsible design professional into the Contractor's supervision of construction.
 - 5. "Equal" or "Equivalent:" As determined by Architect or other responsible design professional as being equivalent, considering such attributes as durability, finish, function, suitability, quality, utility, performance and aesthetic features.
 - 6. "Furnish:" Means "supply and deliver, to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations."
 - 7. "Indicated:" The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as "shown", "noted", "scheduled", and "specified" are used to help the reader locate the reference. There is no limitation on location.
 - 8. "Install:" Describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.

9. "Installer:"
 - a. "Installer" refers to the Contractor or an entity engaged by the Contractor, such as an employee, subcontractor, or sub-subcontractor for performance of a particular construction activity, including installation, erection, application and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - b. "Experienced Installer:" The term "experienced," when used with "installer" means having a minimum of 5 previous Projects similar in size to this Project, knowing the precautions necessary to perform the Work, and being familiar with requirements of authorities having jurisdiction over the Work.
10. "Jobsite:" Same as site, Area of Work, or other similar term referencing the physical property where the work is to be carried out upon.
11. "Necessary:" With due considerations of the conditions of the Project and as determined in the professional judgment of the Architect or other responsible design professional as being necessary for performance of the Work in conformance with the requirements of the Contract Documents, but excluding matters regarding the means, methods, techniques, sequences and procedures of construction.
12. "Noted:" Same as "Indicated."
13. "Per:" Same as "in accordance with," "according to" or "in compliance with."
14. "Products:" Material, system or equipment.
15. "Project Site:" Same as "Site." See definition of "Jobsite" above.
16. "Proper:" As determined by the Architect or other responsible design professional as being proper for the Work, excluding matters regarding the means, methods, techniques, sequences and procedures of construction, which are solely the Contractor's responsibility to determine.
17. "Provide:" Means "furnish and install, complete and ready for the intended use."
18. "Regulation:" Includes laws, ordinances, statutes and lawful orders issued by authorities having jurisdiction, as well as and rules, conventions and agreements within the construction industry that control performance of the Work.
19. "Required:" Necessary for performance of the Work in conformance with the requirements of the Contract Documents, excluding matters regarding the means, methods, techniques, sequences and procedures of construction, such as:
 - a. Regulatory requirements of authorities having jurisdiction.
 - b. Requirements of referenced standards.
 - c. Requirements generally recognized as accepted construction practices of the locale.
 - d. Notes, schedules and graphic representations on the Drawings.
 - e. Requirements specified or referenced in the Specifications.
 - f. Duties and responsibilities stated in the Bidding and Contract Requirements.
20. "Scheduled:" Same as "Indicated."

21. "Selected:" As selected by the University's Representative, Architect or other responsible design professional from the full selection of the manufacturer's products, unless specifically limited in the Contract Documents to a particular quality, color, texture or price range.
22. "Shown:" Same as "Indicated."
23. "Site:" Same as "Site of the Work" or "Project Site;" the area or areas or spaces occupied by the Project and including adjacent areas and other related areas occupied or used by the Contractor for construction activities, either exclusively or with others performing other construction on the Project. The extent of the Project Site is shown on the Drawings, and may or may not be identical with the description of the land upon which the Project is to be built.
24. "Supply:" See "Furnish."
25. "Testing Laboratory" or "Testing Laboratories:" An independent entity engaged to perform specific inspections or tests, at the Project Site or elsewhere, and to report on, and, if required, to interpret, results of those inspections or tests. Refer to Section 01458 - Testing Laboratory Services.
26. "Testing and Inspection Agency:" Same as "Testing Laboratory."

1.6 ABBREVIATIONS, ACRONYMS, NAMES AND TERMS, GENERAL

- A. Abbreviations, Acronyms, Names and Terms: Where acronyms, abbreviations, names and terms are used in the Drawings, Specifications or other Contract Documents, they shall mean the recognized name of the trade association, standards generating organization, authority having jurisdiction or other entity applicable.
- B. Abbreviations, General: The following are commonly-used abbreviations which may be found on the Drawings or in the Specifications. Refer to the Drawings for additional abbreviations or acronyms. This is a partial list. If there is any discrepancy or confusion, notify the University in writing by RFI:

AC or ac	Alternating current or air conditioning (depending upon context)
AMP or amp	Ampere
C	Celsius
CFM or cfm	Cubic feet per minute
CM or cm	Centimeter
CY or cy	Cubic yard
DC or dc	Direct current
DEG or deg	Degrees
F	Fahrenheit
FPM or fpm	Feet per minute
FPS or fps	Feet per second
FT or ft	Foot or feet
Gal or gal	Gallons
GPM or gpm	Gallons per minute
IN or in	Inch or inches
Kip or kip	Thousand pounds

KSI or ksi	Thousand pounds per square inch
KSF or ksf	Thousand pounds per square foot
KV or kv	Kilovolt
KVA or kva	Kilovolt amperes
KW or kw	Kilowatt
KWH or kwh	Kilowatt hour
LBF or lbf	Pounds force
LF or lf	Lineal foot
M or m	Meter
MPH or mph	Miles per hour
MM or mm	Millimeter
PCF or pcf	Pounds per cubic foot
PSF or psf	Pounds per square foot
PSI or psi	Pounds per square inch
PSY or psy	Per square yard
SF or sf	Square foot
SY or sy	Square yard
V or v	Volts

- C. Abbreviations and Acronyms for 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 Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."
- D. Undefined Abbreviations, Acronyms, Names and Terms: Words and terms not otherwise specifically defined in this Section, in the Instructions to Bidders, in the Contract General Conditions, on the Drawings or elsewhere in the Specifications, shall be as customarily defined by trade or industry practice, by reference standard and by specialty dictionaries such as the following:
1. Dictionary of Architecture and Construction, Third Edition (Cyril M. Harris, McGraw-Hill Book Company, 2000).
 2. The American Institute of Architects (AIA) Document M101, "Glossary of Construction Industry Terms."
 3. Encyclopedia of Associations, published by Gale Research Co., commonly available in public libraries.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 45 00 - QUALITY CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Regulatory requirements for testing and inspection.
- B. Contractor's quality control.
- C. Quality of the Work.
- D. Inspections and tests by authorities having jurisdiction.
- E. Inspections and tests by serving utilities.
- F. Inspections and tests by manufacturer's representatives.

1.3 RELATED SECTIONS

- A. Section 01 31 00 - Coordination: Coordination of Work under Contract.
- B. Section 01 41 00 - Regulatory Requirements: Compliance with applicable codes, ordinances and standards.
- C. Section 01 45 29 - Testing Laboratory Services: Selection of independent testing and inspection laboratory; tests and inspections conducted by testing laboratory.
- D. Section 01 61 00 - Basic Product Requirements: Product options, substitutions, transportation and handling requirements, storage and protection requirements, and system completeness requirements.

1.4 REGULATORY REQUIREMENTS FOR TESTING AND INSPECTION

- A. Building Code Requirements: Comply with requirements for testing and inspections in the California Building Code (CBC), as interpreted by authorities having jurisdiction. Additional requirements for testing and inspection, as adopted by authorities having jurisdiction, shall be included in the Contract Sum and Contract Time.
- B. Requirements of Fire Regulations: Comply with testing and inspection requirements of the Fire Marshal having jurisdiction. All tests and inspections shall be included in Contract Sum and Contract Time.

1.5 CONTRACTOR'S QUALITY CONTROL

- A. Contractor's Quality Control: Contractor is solely responsible for the quality of Work. Contractor shall ensure that products, services, workmanship and site conditions comply with requirements of the Drawings and Specifications by coordinating, supervising, testing and inspecting the Work and by utilizing only suitably qualified personnel.
- B. Quality Requirements: Work shall be accomplished in accordance with quality requirements of the Drawings and Specifications, including, by reference, all Codes, laws, rules, regulations and standards. When no quality basis is prescribed, the quality shall be in accordance with the best accepted practices of the construction industry for the locale of the Project, for projects of this type.
- C. Quality Control Personnel: Contractor shall employ and assign knowledgeable and skilled personnel as necessary to perform quality control functions to ensure that the Work is provided as required.
- D. Coordination of Field Quality Control: The General Contractor is solely responsible to coordinate and schedule field quality assurance activities of University's testing and inspection agency and inspectors from authorities having jurisdiction. The University will not coordinate or schedule quality assurance activities on behalf of the Contractor.

1.6 QUALITY OF THE WORK

- A. Quality of Products: Unless otherwise indicated or specified, all products shall be new, free of defects and fit for the intended use.
- B. Quality of Installation: All Work shall be produced plumb, level, square and true, or true to indicated angle, and with proper alignment and relationship between the various elements.
- C. Protection of Existing and Completed Work: Take all measures necessary to preserve and protect existing and completed Work free from all damage, deterioration, soiling and staining, until Acceptance by the University. This includes but is not limited to rain and wind conditions, subcontractor damage of installed or existing products, or similar conditions. All damage shall be deemed non-conforming until such time the work is corrected to the satisfaction of the contract documents.
- D. Standards and Code Compliance and Manufacturer's Instructions and Recommendations: Unless more stringent requirements are indicated or specified, comply with manufacturer's instructions and recommendations, reference standards and building code research report requirements in preparing, fabricating, erecting, installing, applying, connecting and finishing Work.
- E. Deviations from Standards and Code Compliance and Manufacturer's Instructions and Recommendations: Document and explain all deviations from reference standards and building code research report requirements and manufacturer's product installation instructions and recommendations, including acknowledgement by the manufacturer that such deviations are acceptable and appropriate for the Project.
- F. Verification of Quality: Work shall be subject to verification of quality by University or Architect in accordance with provisions of the Contract General Conditions.

1. Contractor shall cooperate by making Work available for inspections and observations by University's Representative, Architect and their consultants.
 2. Such verification may include mill, plant, shop, or field inspection, as required.
 3. Provide access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.
 4. Provide all information and assistance as necessary, including that from subcontractors, fabricators, materials suppliers and manufacturers, for verification of quality by University's Representative or Architect.
 5. Contract modifications, if any, resulting from such verification activities shall be governed by applicable provisions in the Contract General Conditions.
- G. Observations by Architect and Architect's Consultants: Periodic and occasional observations of Work in progress will be made by Architect and Architect's consultants as deemed necessary to review progress of Work and general conformance with the plans and specifications.
- H. Limitations on Inspection, Test and Observations: Employment of an independent testing and inspection agency and observations by Architect and Architect's consultants shall not relieve Contractor of the obligation to perform Work in full conformance to all requirements of Contract Documents and applicable Building Code and other regulatory requirements.
- I. Rejection of Work: The University reserves the right to reject any and all Work not in conformance to the requirements of the Contract Documents.
- J. Correction of Non-Conforming Work: Non-conforming Work shall be modified, replaced, repaired or redone by the Contractor at no change in Contract Sum or Contract Time.
- K. Acceptance of Non-Conforming Work: Acceptance of non-conforming Work, without specific written acknowledgement and approval of the University's Representative, shall not relieve the Contractor of the obligation to correct such Work.
- L. Contract Adjustment for Non-conforming Work: Should University's Representative determine that it is not feasible or not in University's interest to require non-conforming Work to be repaired or replaced, an equitable reduction in Contract Sum shall be made by agreement between University's Representative and Contractor. If an equitable amount cannot be agreed upon, a Field Instruction will be issued and the amount in dispute resolved in accordance with applicable provisions of the Contract General Conditions.
- M. Non-Responsibility for Non-Conforming Work: Architect and Architect's consultants disclaim any and all responsibility for Work produced that is not in conformance with the Contract Drawings and Contract Specifications.

1.7 INSPECTIONS AND TESTS BY AUTHORITIES HAVING JURISDICTION

- A. Inspections and Tests by Authorities Having Jurisdiction: Contractor shall cause all tests and inspections required by authorities having jurisdiction to be made for Work under this Contract.
 - 1. Except as specifically noted, scheduling, coordinating and conducting such inspections and tests shall be solely the Contractor's responsibility.
 - 2. All time required for inspections and tests by authorities having jurisdiction shall be included in the Contract Time.
 - 3. Costs for inspections and tests by authorities having jurisdiction will be paid by University. Any re-test or additional cost incurred due to initial failure or a lack of preparedness shall be charged to the Contractor and a deductive change order processed.

1.8 INSPECTIONS AND TESTS BY SERVING UTILITIES

- A. Inspections and Tests by Serving Utilities: Contractor shall cause all tests and inspections required by serving utilities to be made for Work under the Contract.
 - 1. Except as specifically noted, scheduling, coordinating and conducting such inspections and tests shall be solely the Contractor's responsibility. All time required for inspections and tests by serving utilities shall be included in the Contract Time.
 - 2. Except as specifically noted, all costs for inspections and tests by serving utilities shall be included in the Contract Sum. All costs for retest due to the original test failure will be paid for by the Contractor.

1.9 INSPECTIONS AND TESTS BY MANUFACTURER'S REPRESENTATIVES

- A. Inspections and Tests by Manufacturer's Representatives: Contractor shall cause all specified tests and inspections to be conducted by materials or systems manufacturers. Additionally, all tests and inspections required by materials or systems manufacturers as conditions of warranty or certification of Work shall be made, the cost of which shall be included in the Contract Sum.
 - 1. Scheduling, coordinating and conducting such inspections and tests shall be solely the Contractor's responsibility. All time required for inspections and tests by manufacturer's representatives shall be included in the Contract Time.
 - 2. All costs for inspections and tests by manufacturer's representatives shall be included in the Contract Sum.

1.10 INSPECTIONS BY INDEPENDENT TESTING AND INSPECTION AGENCY

- A. Inspections by independent Testing Laboratory: Refer to Section 01 45 29 - Testing Laboratory Services.

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

Not applicable to this Section.

END OF SECTION

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SECTION 01 45 05 - MOCK UPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Full scale mock-ups for visual qualities.

1.3 RELATED SECTIONS

THE FOLLOWING ARE EXAMPLES ONLY. LIST SECTIONS APPLICABLE TO PROJECT, REQUIRING MOCK-UPS.

- A. Section 07 10 00 – Dampproofing and Waterproofing
- B. Section 08 80 00 - Glazing
- C. Section 09 21 00 – Plaster and Gypsum Board Assemblies
- D. Section 09 30 00 - Tiling
- E. Section 09 60 00 - Flooring
- F. Section 09 90 00 – Painting and Coating
- G. Section 10 14 00 – Signage
- H. Section 12 30 00 – Casework
- I. Section 32 05 23 - Portland Cement Concrete Paving (for review of color and finish)
- J. Section 32 13 73 – Concrete Paving Joint Sealants

1.4 DEFINITIONS

- A. Mock-Ups: Full-size, physical example assemblies to illustrate finishes and materials.
 - 1. Mock-ups are used to verify selections made under Sample submittals, to demonstrate aesthetic

effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.

2. Mock-ups establish the standard by which the Work will be judged.

1.5 SUBMITTALS

- A. Product Data and Shop Drawings: For each product or system that will be incorporated in the mock-ups, submit required submittals as specified in applicable product Section of the Specifications.

1.6 QUALITY ASSURANCE

- A. Mock-Ups: Before installing portions of the Work requiring mock-ups, build mock-ups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 1. Build mock-ups in location and of size indicated or, if not indicated, as directed by University's Representative.
 2. Notify University's Representative and Architect minimum of seven days in advance of dates and times when mock-ups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain review and acceptance of mock-ups by Architect and University's Representative before starting Work, including fabrication and installation construction.
 5. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Demolish and remove mock-ups when directed, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MOCK-UPS FOR VISUAL QUALITIES

- A. Mock-Ups for Visual Qualities: Before installing portions of the Work requiring a mock-up, build the mock-ups with each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 1. Construct field mock-ups as indicated on the Drawings, indicating assemblies and interfaces of materials.
 2. Construct mock-ups at location where directed by University's Representative.
 3. Demonstrate the proposed range of visual effects, qualities and workmanship.
 4. Provide structural substrate for mock-ups as suitable. Mock-ups shall be free standing and self-

supporting.

5. Maintain mock-ups during construction in an undisturbed condition as a standard for judging completed Work.
6. Demolish and legally dispose of mock-ups when directed, unless otherwise indicated.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF MOCK-UPS FOR VISUAL QUALITIES

- A. Mock-Ups for Visual Qualities, General: Construct mock-ups as noted on the Drawings and specified in individual product Sections of the Specifications, including but not limited to the the following:
 1. Casework:
 - a. Typical base cabinet, plastic laminate countertop and wall cabinet, including ceiling and wall trim.
 2. Ceramic tile: Toilet room, floor and wall tile including:
 - a. Intersections of floor-wall and wall-ceiling.
 - b. Transition from wall tile finish to gypsum board finish (including wallcovering, where applicable).
 - c. Inside corner of tile covered wall.
 - d. Shower curb if applicable.
 3. Flooring
 - a. Polished or stained concrete flooring where applicable.

END OF SECTION

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SECTION 01 45 23 - TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Administrative and procedural requirements for quality assurance services.
 - 1. Quality assurance services include inspections and tests and related actions including reports, performed by independent agencies, and governing authorities. They do not include Contract enforcement activities performed by the Trustees or Architect.
 - 2. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor of responsibility for compliance with Contract Document requirements.

1.3 RELATED SECTIONS

- A. Section 01 45 00 - Quality Control: General requirements for inspections and tests.
- B. Individual Product Specifications Sections: Specific requirements for inspections and tests.

1.4 RESPONSIBILITIES

- A. Testing Agency: For the purpose of this specification "Testing Agency" shall include any persons designated by the University to ensure the work is conforms to the contract documents. This definition shall include the Inspector of Record and Special Inspector. Trustees will engage and pay for the services of an independent agency to perform inspections and tests specified as the Trustees' responsibility for both on-site and off-site testing and inspecting. Refer to paragraph E for travel restrictions.
 - 1. Where the Trustees have engaged a testing agency or other entity for testing and inspection of a part of the Work, and the Contractor is also required to engage an entity for the same or related element, the Contractor shall not employ the entity engaged by the Trustees, unless otherwise agreed in writing with the Trustees.
- B. Retesting: The Contractor is responsible for the cost of retesting where results of required inspections, tests or similar services prove unsatisfactory and do not indicate compliance with Contract Document requirements, regardless of whether the original test was the Contractor's responsibility.
 - 1. Cost of retesting construction revised or replaced by the Contractor is the Contractor's

responsibility, where required tests were performed on original construction.

- C. Associated Services: The Contractor shall cooperate with agencies performing required inspections, tests and similar services and provide reasonable auxiliary services as requested.
- D. Coordination: The Contractor, Project Manager/Inspector, and each agency engaged to perform inspections, testing and similar services shall coordinate the sequence of activities to accommodate required services with a minimum of delay. In addition the Contractor shall coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
 - 1. The Contractor is responsible for communicating to the Project Manager/Inspector the scheduling times for inspections, tests, taking samples and similar activities. The contractor shall formally request all inspections.
- E. Payment for Testing Agency Services:
 - 1. Unless otherwise specified, Trustees will pay for tests and inspections performed by Testing Agency, as specified in individual product Sections of the Specifications. Overtime costs due to scheduling for the convenience of the Contractor or to make up for Work behind schedule shall be deducted by Change Order from Contract Sum.
 - 2. When tests and inspections are required on an overtime basis, initial payment will be made by the Trustees. All costs for overtime testing and inspections shall be deducted by Change Order from Contract Sum.
 - a. The deducted cost will be for the full amount and shall not include any mark-up factor.
 - 3. Unless otherwise specified, Contractor shall be back-charged for mileage and travel time for inspection services requiring more than 100 miles from Project site to test products purchased or fabricated by Contractor.
 - a. Testing Agency shall forward all billings and records of such costs to University's Representative for approval.
 - b. Such costs, if determined by University's Representative to be attributable to the Contractor under this provision, shall be deducted by Change Order from Contract Sum.
 - 4. Contractor shall pay all costs for repeated observations, re-inspection or retesting by Testing Agency due to non-conforming Work. Costs shall be deducted by Change Order from Contract Sum.
 - a. The deducted cost will be for the full amount and shall not include any mark-up factor.
 - 5. Additional Tests, Inspections and Related Services: Contractor shall be charged costs for additional tests, inspections and related services, due to the following. Such costs shall be deducted by Change Order from Contract Sum.
 - a. Work is not ready to inspect when inspectors arrive.
 - b. Failure to properly schedule or notify testing and inspection agency or authorities having jurisdiction.
 - c. Changes in sources, lots or suppliers of products after original tests or inspections.
 - d. Changes in means methods, techniques, sequences and procedures of construction that

- necessitate additional testing, inspection and related services.
- e. Changes in mix designs for concrete and mortar after review and acceptance of submitted mix design.
 - f. Multiple off-site fabrication sites.
 - g. Fabrication and installation errors.
 - h. Inefficient, sporadic, or poorly organized manufacturing that causes additional testing costs to be incurred.
- F. Segregation in Billing of Overtime Services: Billings for overtime services shall have straight time and overtime costs segregated and shall have substantiation by detailed explanations justifying necessity of services on overtime basis.
- G. Obligation to Perform Work According to Contract Documents: Employment of Testing Agency shall in no way relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents and applicable Codes.
- H. Limits on Testing Agency's Authority:
- 1. Testing Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Testing Agency may not approve or accept any portion of the Work. Inspection includes only a confirmation that the installation meets the details in the plans and specifications.
 - 3. Testing Agency may not assume any duties of Contractor and will not assist or direct work in any way nor will testing agency coordinate work of other contractors.
 - 4. Testing Agency shall have the authority to stop work when it in direct conflict with contract documents, code or when work poses a risk to the safety of personnel.
- I. Contractor shall make the Work in all stages of progress available for University personal and continuous observation by the Testing Agency.
- 1. Testing Agency shall have free access to any and all parts of the Work at all times.
 - 2. Contractor shall provide the Testing Agency with reasonable facilities for Testing Agency to obtain such information as Testing Agency determines is necessary for Testing Agency to be kept fully informed of the progress and manner of performance of the Work and character of products, according to Testing Agency's duties and responsibilities.
 - 3. Observation and inspection of the Work by Testing Agency shall not relieve Contractor from any obligation to fulfill the requirements of the Contract.
- J. Retesting: When materials tested fail to meet requirements herein specified, they shall be promptly corrected or removed and replaced at the expense of the Contractor and retested in a manner required by University's Representative. Costs involved in retesting shall be deducted by Change Order from Contract Sum.

1.5 TESTS AND INSPECTIONS

TESTING AND INSPECTING SERVICES

- A. Tests and Inspections, General: All construction work shall be subject to inspection by the Trustees and the Architect and all such construction or work shall remain accessible and exposed for inspection purposes until approved by the Trustees.
 - 1. The Trustees will provide project personnel, including inspectors, to be available at the project site.
 - 2. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of the building code or of other ordinances of the jurisdiction, including plans and specifications. Inspections presuming to give authority to violate or cancel the provisions of code, or of plans and specifications shall not be valid.
 - 3. It shall be the duty of the contractor to cause the work to remain accessible and exposed for inspection purposes. Neither the Inspector nor the Trustees or Architect shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.

- B. Inspection Requests: It shall be the duty of the Contractor doing the work to notify the Inspector that such work is ready for inspection. The Trustees require that such work is ready for inspection. The Trustees require that every request for inspection be filed at least two business days before such inspection is desired. Such requests shall be in writing.

- C. Approval Required: Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the Inspector. The Inspector, upon notification, shall make the requested inspections and shall either indicate in writing that portion of the construction is satisfactory as completed, or shall notify the Contractor that same fails to comply with plans and specifications. Any portions of Work that do not comply shall be corrected by the Contractor, and such portion shall not be covered or concealed until authorized by the Inspector.
 - 1. There shall be a final inspection and approval of all buildings and structures when completed and ready for occupancy and use.

- D. Inspection Coordination: Contractor shall provide, on a weekly basis, an anticipated Inspection Requirements Schedule, coordinated with the three-week look ahead schedule, showing the anticipated inspection needs for the following three weeks to facilitate appropriate campus coordination and interface as well as mobilization of required inspection staffing.

- E. Required Inspections: Reinforcing steel, structural framework, or interior wall and/or ceiling support framing of any part of any building or structure shall not be covered or concealed without first obtaining the approval of the Inspector.
 - 1. Listed below are the minimum inspection requirements:

Sect #	Section Name	Test	Inspection	Paid By
01 45 00	Quality Control		• Final Inspection	University

Sect #	Section Name	Test	Inspection	Paid By
03 30 00	Cast-In-Place Concrete	<ul style="list-style-type: none"> • Molded Cylinder Test • Concrete Consistency 	<ul style="list-style-type: none"> • Welding Continuous Inspection • Structural Concrete • Special Inspection • Epoxy Anchor Concrete • Embeds 	University
05 12 00	Structural Steel Framing	<ul style="list-style-type: none"> • Bolt Connection Test • Welding • Lamellar Tearing • Prior Testing of Base Material 	<ul style="list-style-type: none"> • Bolt torque • Welding 	University
05 30 00	Metal Decking	<ul style="list-style-type: none"> • Mill Analysis & Test Reports 	<ul style="list-style-type: none"> • Welding • Crimping • Closures 	University
05 41 00	Structural Metal Stud Framing		<ul style="list-style-type: none"> • Field Welds • Material & Equipment • Screws and spans 	University
07 11 13	Bituminous Dampproofing	<ul style="list-style-type: none"> • Site Flood Test 	<ul style="list-style-type: none"> • Periodic Inspection 	University
07 53 23	EPDM Roofing	<ul style="list-style-type: none"> • Defect Testing 	<ul style="list-style-type: none"> • Periodic Inspection • Manufactures Rep 	University
07 84 00	Firestopping		<ul style="list-style-type: none"> • General Inspection 	University
07 95 13	Expansion Joint Cover Assemblies	<ul style="list-style-type: none"> • Exterior Joint Covers • Water Test 	<ul style="list-style-type: none"> • Manufacturer's Field Inspection • Mill Certification 	University
08 51 13	Aluminum Windows	<ul style="list-style-type: none"> • Air Infiltration • Water Infiltration 	<ul style="list-style-type: none"> • Fenestration • Solar Gain 	University
09 29 00	Gypsum Board		<ul style="list-style-type: none"> • Rough Gypsum Board Inspection • Screws 	University
14 21 00	Electric Traction Elevators		<ul style="list-style-type: none"> • Inspections & Permits 	Contractor

Sect #	Section Name	Test	Inspection	Paid By
14 24 00	Hydraulic Elevators		• Inspections & Permits	Contractor
22 05 00	Common Work Results for Plumbing		• Rough Plumbing Inspection • General Pipe Testing • Pressure testing on supply • DWV stack test • Gas line pressure testing •	University Contractor
23 05 00	Common Work Results for HVAC		• Rough Mechanical Inspection	University
23 08 00	Commissioning of HVAC	• Commissioning		Contractor & University
26 05 00	Common Work Results for Electrical	• Electrical Testing	• Rough Electrical Inspection •	University Contractor
26 08 00	Commissioning of Electrical Systems	• Commissioning		Contractor & University
27 05 00	Common Work Results for Communications		• Rough Telecom Inspection	University
27 30 00	Voice Communications			Contractor
31 23 00	Excavation and Fill	• Soils Density Tests • Field Density Tests		University
31 23 13	Subgrade Preparation	• Backfilling & Compaction		University
32 11 23	Aggregate Base Courses	• Compaction		University
32 12 16	Asphalt Paving	• Compaction	• Slope and flow	University

Sect #	Section Name	Test	Inspection	Paid By
32 13 13	Concrete Paving	• Slump Test/ • Compression Test	• Slope and flow	University
32 16 13	Concrete Curbs and Gutters	• Slump Test/ • Compression Test	• Slope and flow	University
32 84 00	Planting Irrigation	• Hydrostatic Test • Operational Testing		University
32 93 00	Planting		• Preliminary Inspection • Field Inspection	University
33 11 00	Water Utility Distribution Piping	• Hydrostatic Tests • Pressure Tests • Leakage Tests		University
33 41 00	Storm Utility Drainage Piping	• Hydrostatic Test on Watertight Joints		University

(ARCHITECT TO REVISE/ ADD TO LIST AS REQUIRED BY PROJECT TECHNICAL DETAILS)

- a. Footings
- b. Underground utilities
- c. Rebar
- d. Fire sprinklers.
- e. Ceiling above t-bar
- f. Welding
- g. Roof/metal deck
- h. Roofing
- i. Insulation
- j. Rated wall penetrations
- k. Rated doors and access panels
- l. High voltage cable installation
- m. High pot high voltage cables

2. The Contractor shall be responsible for reviewing all of the Contract Documents for any additional inspection requirements.

1.6 SUBMITTALS

- A. Reports: Trustees' independent testing agency shall submit a certified written report of each inspection, test or similar service, to the Architect, the Trustees, the Contractor, and the Project Manager/ Inspector.
- B. Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to:

Date of issue

Project title and number
Name, address and telephone number of testing agency
Dates and locations of samples and tests or inspections
Names of individuals making the inspection or test
Designation of the Work and test method
Identification of product and Specification Section
Complete inspection or test data
Test results and an interpretation of test results
Ambient conditions at the time of sample-taking and testing
Comments or professional opinion as to whether inspected or tested
Work complies with Contract Document requirements
Name and signature of laboratory inspector
Recommendations on retesting.

1.7 SCHEDULES FOR TESTING

- A. Testing and Inspection Schedule: After discussion with University's Representative and Testing Agency in advance of performance of testing and inspection services, Contractor shall determine dates and times necessary for Testing Agency to schedule performance of required tests and inspections and determine due dates for issuance of reports.
 - 1. Integrate Testing and Inspection Schedule with the Weekly Project Meetings specified in Section 01 31 19 – Project Meetings
 - 2. Determine and indicate in Testing and Inspection Schedule necessary time for preparation and submission of reports of tests and inspections.
- B. Revising Testing and Inspection Schedule: When changes of the construction schedule are necessary during construction, coordinate all such changes of schedule with the testing Agency as required.
- C. Adherence to Testing and Inspection Schedule: When the Testing Agency is ready to test according to the determined schedule but is prevented from testing or taking specimens due to incompleteness of the work, all extra costs for testing attributed to the delay may be back-charged to the Contractor and shall not be borne by the University.

1.8 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor's Responsibilities for Inspections and Tests:
 - 1. Notify Project Inspector and Testing Agency formally with an Inspection Request form a minimum of two (2) business days in advance of expected time for operations requiring inspection and testing services.
 - a. State Fire Marshal Inspections - Notify Project Inspector a minimum of three (3) business days in advance of expected State Fire Marshal Inspections.
 - b. Architect/Engineer Review – Notify Project Inspector, University Project Manager and Archiect/Engineer a min of five (5) business days in advance of all quality assurance reviews.
 - 2. Deliver to Testing Agency or designated location, adequate samples of materials proposed to be used which require advance testing, together with proposed mix designs or other approved

submittal documentation.

3. Cooperate with University's Representative, Testing Agency, Project Inspector, Architect, Architect's consultants and other responsible design professionals. Provide access to Work areas and off-site fabrication and assembly locations, including during weekends and after normal work hours.
4. Provide incidental labor and facilities to provide safe access to Work to be inspected and tested, to obtain and handle samples at the Work site or at source of products to be tested, and to store and cure test samples.
5. Provide at least 14 days in advance of first inspection or test of each type, a schedule of tests or inspections indicating types of tests or inspections and their scheduled dates.

1.9 INSPECTIONS AND TESTS BY OTHERS

- A. Inspections by Others: Refer to Section 01 45 00 - Quality Control for requirements regarding observations and inspections by University's Representative, Architect and Project Inspector.
- B. Tests by Others: Refer to Section 01 45 00 - Quality Control and individual product Specifications Sections for requirements regarding tests and inspections by product manufacturers and others, including serving utilities.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. Repair and Protection: Upon completion of inspection, testing, sample-taking and similar services, repair damaged construction and restore substrates and finishes to eliminate all deficiencies, including deficiencies in visual qualities of exposed finishes. Comply with Contract Document requirements for "Cutting and Patching."
 1. Protect construction exposed by or for quality control and quality assurance service activities, and protect repaired construction.
 2. Repair and protection of all installed and stored materials is the Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing or similar services.

END OF SECTION

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Statement of Required Project Special Inspections

Project: _____
 Location: _____
 Owner: _____
 Architect _____

This Statement of Special Inspections is submitted in fulfillment of the requirements of CBC Sections 1704 and 1705 and summarizes the special inspections and tests required for this project. Additional tests and inspections may be called for at the discretion of the (deputy) building official.

This statement includes:

- Attachment A: List of the Testing Agencies and Inspectors retained to conduct the tests and inspections.
- Attachment B: Schedule of Special Inspections and tests applicable to this project:
 - Special Inspections per Sections 1704 and 1705
 - Special inspections for Seismic Resistance
 - Special inspections for Wind Resistance

Special inspections and testing shall be performed in accordance with the approved plans and specifications, this statement, and CBC sections 1704, 1705, 1707, and 1708. No less than CBC minimum requirements shall be observed.

Interim reports shall be coordinated by the project Inspector of Record (IOR) and submitted to the (Deputy) Building Official and Architect in accordance with CBC Section 1704.1.2.

A final report of special inspections and confirmation of resolution of discrepancies noted in the inspections shall be submitted by the IOR to the (Deputy) Building Official and Architect. The (Deputy) Building Official shall review and approve the final report as a prerequisite to the issuance of a Certificate of Occupancy.

Responsibility for payment for inspections and testing is defined in project agreements. Typically, it is trustee policy to pay for all initial and reasonable back check inspections.

This Statement has been developed with the understanding that the (Deputy) Building Official will personally or by delegation:

- Review and approve the qualifications of the Special Inspectors who will perform the inspections.
- Monitor special inspection activities on the job site to confirm that the Special Inspectors are qualified and are performing their duties as called for in this Statement of Special Inspection.
- Review submitted inspection reports, confirming resolution of discrepancies as the work progresses.
- Perform all inspections as required by the CBC building code and additionally as identified herein.

Architect:

Signature *Date*

Authorization by Trustees

Signature *Date*

(Deputy) Building Official Acceptance

Signature *Date*

Attachment A - Testing Agencies, and Inspectors

Testing agencies and special inspectors retained to conduct tests and inspection on this project.

Responsibility	Firm	Address, Telephone, e-mail
1. Special Inspection (except for geotechnical)	<i>To Be Determined</i>	
2. Material Testing	<i>To Be Determined</i>	
3. Geotechnical Inspections	<i>To Be Determined</i>	
4. Other	<i>To Be Determined</i>	
5. Other	<i>To Be Determined</i>	

Additional pages attached (if checked)

Attachment B - Special Inspections for Seismic & Wind Resistance

Seismic Requirements (Section 1705.3.1)

Summary description of seismic force resisting system and designated seismic systems requiring special inspections as per Section 1705.3.:

[Sample: Steel moment frame on pier foundation]

Wind Requirements (Section 1705.4.1)

Summary description of main wind force resisting system and designated wind resisting components requiring special inspections in accordance with Section 1705.4.2.:

1. Roof cladding and roof framing connections.
2. Wall connections to roof and floor diaphragms and framing.
3. Roof and floor diaphragm systems, including collectors, drag struts and boundary elements.
4. Braced frame, moment frame and shear walls
5. Braced frame, moment frame and shear walls connections to foundations

[Sample: All elements identified in CBC 1705.4.2. above. No additional items.]

Attachment B - Schedule of Special Inspections (cont.)

Verification and Inspection. (1)	C.	P	Notes
1704.2.1:- Inspect fabricators fabrication and quality control procedures.	---	---	
Table 1704.3 - Steel			
1. Material verification of high-strength bolts, nuts, and washers.			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		X	
b. Manufacturer's certificate of compliance required.		X	
2. Inspection of high-strength bolting:			
a. Bearing type connections.		X	
b. Slip-critical connections	X	X	
3. Material verification of structural steel:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.	---	---	
b. Manufacturer's mill test reports	---	---	
4. Material verification of weld filler materials:			
a. Identification markings to conform to AWS designation listed in the WPS.	---	---	
b. Manufacturer's certificate of compliance required.	---	---	
5. Inspection of welding:			
a. Structural steel			
1) Complete and partial penetration groove welds.	X		
2) Multipass fillet welds	X		
3) Single-pass fillet welds > 5/16"	X		
4) Single-pass fillet welds ≤ 5/16"		X	
5) Floor and roof deck welds.		X	
b. Reinforcing steel			
1) Verification of weldability of reinforcing steel other than ASTM A 706.		X	
2) Reinforcing steel-resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special reinforced concrete shear walls, and shear reinforcement.	X		
3) Shear reinforcement.	X		
4) Other reinforcing steel		X	
6. Inspection of steel frame joint details for compliance with approved construction documents:		X	
a. Details such as bracing and stiffening.			
b. Member locations.			
c. Application of joint details at each connection.			

Verification and Inspection. (1)	C.	P	Notes
1704.3- Welded studs when used for structural diaphragms.		X	
1704.3- Welding of cold-formed sheet steel framing members.		X	
1704.3- Welding of stairs and railing systems		X	
Table 1704.4 - Concrete			
1. Inspection of reinforcing steel, including prestressing tendons and placement		X	
2. Inspection of reinforcing steel welding in accordance with Table 1704.3 Item 5b	---	---	
3. Inspect bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased.	X		
4. Verifying use of required design mix.		X	
5. At time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests and determine the temperature of the concrete.	X		
6. Inspection of concrete and shotcrete placement for proper application techniques.	X		
7. Inspection for maintenance of specified curing temperature and techniques.		X	
8. Inspection of prestressed concrete			
a. Application of prestressing forces	X		
b. Grouting of bonded prestressing tendons in the seismic-force-resisting system	X		
9. Erection of precast concrete members.		X	
10. Verification of in-situ concrete strength, prior to stressing of tendons in postensioned concrete and prior to removal of shores and forms from beams and structural slabs.		X	
11. Inspect formwork for shape, location, and dimensions of the concrete member being formed.		X	
Table 1704.5.1 - Level 1 Masonry Inspections.			
1. At the start of masonry construction verify the following to ensure compliance:			
a. Proportions of site-prepared mortar.		X	
b. Construction of mortar joints.		X	
c. Location of reinforcement, connectors, prestressing tendons, and anchorages.		X	
d. Prestressing technique.		X	
e. Grade and size of prestressing tendons and anchorages.		X	
2. Verify:			
a. Size and location of structural elements.		X	
b. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.		X	
c. Specified size, grade, and type of reinforcement.		X	

Verification and Inspection. (1)	C.	P	Notes
d. Welding of reinforcing bars.	X		
e. Protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F)		X	
f. Application and measurement of prestressing force.		X	
3. Prior to grouting verify the following to verify compliance.			
a. Grout space is clean.		X	
b. Placement of reinforcement and connectors and prestressing tendons and anchorages.		X	
c. Proportions of site-prepared grout and prestressing grout for bonded tendons.		X	
d. Construction of mortar joints.		X	
4. Verify grout placement to ensure compliance with code and construction document provisions.	X		
a. Observe grouting of prestressing bonded tendons.	X		
5. Observe preparation of required grout specimens, mortar specimens, and/or prisms.	X		
6. Verify compliance with required inspection provisions of the construction documents and the approved submittals.		X	
Table 1704.5.3 - Level 2 Masonry Inspections			
1. From the beginning of masonry construction the following shall be verified to ensure compliance:			
a. Proportions of site-prepared mortar, grout, and prestressing grout for bonded tendons.		X	
b. Placement of masonry units and construction of mortar joints.		X	
c. Placement of reinforcement, connectors and prestressing tendons and anchorages.		X	
d. Grout space prior to grouting.	X		
e. Placement of grout.	X		
f. Placement of prestressing grout.	X		
2. Verify:			
a. Size and location of structural elements.		X	
b. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames and other construction.	X		
c. Specified size, grade, and type of reinforcement.		X	
d. Welding of reinforcing bars.	X		

Verification and Inspection. (1)	C.	P	Notes
e. Protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F)		X	
f. Application and measurement of prestressing force.	X		
3. Preparation of any required grout specimens, mortar specimens, and/or prisms shall be observed.	X		
4. Compliance with required provisions of construction documents and the approved submittals shall be verified.		X	
1704.6: -Inspect pre fabricated wood structural elements and assemblies in accordance with Section 1704.2	---	---	
1704.6:- Inspect site built assemblies.	---	---	
1704.6.1: Inspect high-load diaphragms :			
1. Verify grade and thickness of sheathing.	---	---	
2. Verify nominal size of framing members at adjoining panel edges.	---	---	
3. Verify: <ul style="list-style-type: none"> • Nail or staple diameter and length, • Number of fastener lines, • Spacing between fasteners in each line and at edge margins. 	---	---	
Table 1704.7 - Inspection of Soils			
1. Verify materials below footings are adequate to achieve the desired bearing capacity.		X	
2. Verify excavations are extended to proper depth and have reached proper material.		X	
3. Perform classification and testing of controlled fill materials.		X	
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of controlled fill.	X		
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.		X	
Table 1704.8 - Pile Foundations			
1. Verify pile materials, sizes and lengths comply with the requirements.	X		
2. Determine capacities of test piles and conduct additional load tests, as required.	X		
3. Observe driving operations and maintain complete and accurate records for each pile.	X		

Verification and Inspection. (1)	C.	P	Notes
4. Verify locations of piles and their plumbness. a. Confirm type and size of hammer. b. Record number of blows per foot of penetration. c. Determine required penetrations to achieve design capacity. d. Record tip and but elevations and record any pile damage.	X		
5. For steel piles, perform additional inspections in accordance with Section 1704.3.	---	---	
7. For specialty piles, perform additional inspections as determined by the registered design professional in responsible charge.	---	---	
8. For augered uncased piles and caisson piles, perform inspections in accordance with Section 1704.9.	---	---	
Table 1704.9 - Pier Foundations			
1. Observe drilling operations and maintain complete and accurate records for each pier.	X		
2. Verify locations of piers and their plumbness. Confirm: • Pier diameters, • Bell diameters (if applicable), • Lengths, embedment into bedrock (if applicable), • Adequate end strata bearing capacity.	X		
1704.10- Sprayed fire-resistant materials			
1. Inspect surface for accordance with the approved fire-resistance design and the approved manufacturer's written instructions.	---	---	
2. Verify minimum ambient temperature before and after application.	---	---	
3. Verify ventilation of area during and after application.		X	
4. Measure average thickness per ASTM E605 and Section 1704.10.3.	---	---	
5. Verify density of material for conformance with the approved fire-resistant design and ASTM E605.	---	---	
6. Test cohesive/adhesive bond strength per Section 1704.10.5.	---	---	
1704.11- Mastic and intumescant fire-resistant coating			
1704.12- Exterior insulation and finish systems (EIFS):-			
1704.13- Alternate materials and systems.			
1704.14- Smoke Control System			
1705.3: Seismic Resistance.			
1705.3 [4.3]:- Suspended ceiling systems and their anchorage.	---	---	

Verification and Inspection. (1)	C.	P	Notes
1705.4 Wind Resistance			
1705.4.2	---	---	
1. Roof cladding and roof framing connections.			
2. Wall connections to roof and floor diaphragms and framing.	---	---	
3. Roof and floor diaphragm systems, including collectors, drag struts and boundary elements	---	---	
4. Vertical wind force-resisting systems, including braced frames, moment frames, and shear walls.	---	---	
5. Wind force-resisting system connections to the foundation.	---	---	
6. Fabrication and installation of systems or components required to meet the impact resistance requirements of Section 1609.1.2	---	---	
Special Inspections for Seismic Resistance.			
1707.2:- Special inspection for welding in accordance with AISC 341.	X		
1707.3:- Structural Wood.			
1. Inspect field gluing operations of elements of the seismic-force-resisting system.	X		
2. Inspect nailing, bolting, anchoring, and other fastening of components within the seismic-force-resisting system, including: <ul style="list-style-type: none"> • wood shear walls, • wood diaphragms, • drag struts, braces, • shear panels, • hold-downs. 		X	
1707.4:- Cold-formed steel framing:			
1. Welding of elements of the seismic-force-resisting system.		X	
2. Inspection of screw attachments, bolting, anchoring, and other fastening of components within the seismic-force-resisting system including struts, braces, and hold-downs.		X	
1707.5: Pier Foundations			
1. Placement of reinforcing		X	
2. Placement of concrete	X		
1707.6:- Anchorage of storage racks and access floors 8 feet or greater in height.		X	
1707.7: Architectural Components			
1. Inspect erection and fastening of exterior cladding weighing more than 5 psf.		X	
2. Inspect erection and fastening of interior and exterior non-bearing walls weighing more than 15 psf.		X	
3. Inspect erection and fastening of interior and exterior veneer weighing more than 5 psf.		X	
1707.8: Mechanical and electrical components.			
1. Inspect anchorage of electrical equipment for emergency or stand-by power systems.		X	

Verification and Inspection. (1)	C.	P	Notes
2. Inspect anchorage of non-emergency electrical equipment		X	
3. Inspect installation of piping systems and associated mechanical units carrying flammable, combustible, or highly toxic contents.		X	
4. Inspect installation of HVAC ductwork that contains hazardous materials.		X	
5. Inspect installation of vibration isolation systems where required by Section 1707.8.		X	
1707.9: Verify that the equipment label and anchorage or mounting conforms to the certificate of compliance when mechanical and electrical equipment must be seismically qualified.	---	---	
1707.10- Seismic isolation system:- Inspection of isolation system per ASCE 7 – Section 17.2.4.8		X	
1708.1: Masonry Testing for Seismic Resistance			
1708.1.1- Verify certificates of compliance prior to construction.	---	---	
1708.1.2- Verification of f'_m and f'_{AAC} prior to construction.	---	---	
1708.1.2- Verification of f'_m and f'_{AAC} every 5000 square feet during construction.		X	
1708.1.4- Verification of proportions of materials in mortar and grout as delivered to the site.	---	---	
1708.3- Obtain mill certificates for reinforcing steel, verify compliance with approved construction documents, and verify steel supplied corresponds to certificate.	---	---	
1708.4- Structural Steel: - Invoke the QAP Quality Assurance requirements in AISC 341.	---	---	
1708.5- Obtain certificate that equipment has been tested per Section 1708.5.	---	---	
1708.6- Obtain system tests as required by ASCE 7 Section 17.8	---	---	

Notation:

Column headers:

C Indicates continuous inspection is required.

P Indicates periodic inspections are required. The Notes and or contract documents should clarify.

Box entries:

X Is placed in the appropriate column to denote either "C" continuous or "P" periodic inspections.

--- Denotes an activity that is either a one-time activity or one whose frequency is defined in some other manner.

Notes:

- (1) Additional detail regarding inspections and tests are provided in the project specifications and construction documents

Attachment B - Schedule of Special Inspection (cont.)

Other Inspections

Other inspections not listed previously or additional notes

[none]

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SECTION 01 51 00 - TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Temporary utilities and services, including:
 - 1. Heating and cooling during construction
 - 2. Ventilation during construction
 - 3. Temporary water service
 - 4. Temporary sanitary facilities
 - 5. Temporary power and lighting
 - 6. Construction telephone service.
 - 7. Contractor metering and payment of Electrical and Water service usage
- B. Removal of temporary utilities.

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises.
- B. Section 01 33 00 – Submittal Procedures

1.4 SUBMITTALS

- A. Temporary Utilities: Submit reports of tests, inspections, applicable meter readings and similar procedures performed on temporary utilities.

1.5 TEMPORARY UTILITIES AND SERVICES

- A. Temporary Utilities and Services, General: All utilities and other services necessary for proper performance of the Work shall be provided by Contractor, unless specifically noted otherwise. Refer to Contract General Conditions, Article 4.11. Temporary utilities and services shall conform to all applicable requirements of authorities having jurisdiction and serving utility companies and agencies, including the following:

1. Requirements of authorities having jurisdiction, including:
 - a. Cal OSHA
 - b. California Building Code (CBC) requirements
 - c. Health and safety regulations
 - d. Utility agency and company regulations
 - e. Police, Fire Department and Rescue Squad rules
 - f. Environmental protection regulations
 2. Standards:
 - a. NFPA Document 241 - Building Construction and Demolition Activities.
 - b. ANSI A10 Series - Safety Requirements for Construction and Demolition.
 - c. NECA Electrical Design Library - Temporary Electrical Facilities.
 - d. Electrical Service: Comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with California Electrical Code (CEC).
 - e. Piped or Plumbed systems – Install service in accordance with California Plumbing Code (CPC)
- B. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.
- C. Temporary Connections and Fees: Contractor shall arrange for services and pay all fees and service charges for temporary power, water, sewer, gas and other utility services necessary for the Work.
1. Contractor shall apply for and obtain permits for temporary utilities, including permits for temporary generators, from authorities having jurisdiction.
 2. All costs for temporary connections, including fees charged by serving utilities, shall be included in Contract Sum. Rates to be included in the contract sum shall be as follows:
 - a. Electrical power consumption will be billed monthly to the contractor at \$0.13 per khw (kilowatt hour)
 - b. Water consumption will be billed monthly to the Contractor at \$6.50 per hcf (hundred cubic feet)
- D. Permanent Connections and Fees: Contractor shall arrange for utility agencies and companies to make permanent connections. University will arrange for permanent utility account and pay permanent connection fees. After Contract Completion review and determination that Work is acceptable, University will pay utility service charges for services delivered through permanent connections, for normal quantities.
- E. Use of Temporary Utilities: Enforce strict discipline in use of temporary utilities to conserve on consumption. Limit use of temporary utilities to essential and intended uses to minimize waste and abuse.

1.6 PROJECT CONDITIONS

- A. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous, dangerous, or unsanitary conditions,

or public nuisances to develop or persist on the site.

1.7 HEATING AND COOLING

- A. Temporary Heating and Cooling: Provide and pay for temporary heating and cooling devices, fuel and related service charges to provide ambient temperatures as required to maintain conditions necessary for proper performance of construction activities.
- B. Use of Permanent Heating and Cooling Systems: Permanent heating and cooling equipment may be used after completion, testing and inspection of systems and approval of code authorities having jurisdiction.
 - 1. Prior to operation of permanent heating equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place.
 - 2. Contractor shall provide and pay for operation, maintenance and regular replacement of filters and worn or consumed parts.
 - 3. Immediately prior to Contract Completion review, change disposable filters and clean permanent filters of equipment used during construction.
 - 4. Contractor use of the equipment does not start the warrantee period. Refer to Specification section 01 78 33 for additional information.
- C. Temperature Criteria: Maintain interior ambient temperature of minimum 50 degrees F and maximum 80 degrees F, unless otherwise specified or approved by University's Representative.

1.8 VENTILATION DURING CONSTRUCTION

- A. Ventilation During Construction: Provide and pay for temporary ventilation devices, energy and related service charges.
- B. Use of Permanent Ventilation Systems: The Contractor may use permanent ventilation equipment after completion, testing and inspection of systems and approval by University's Representative and authorities having jurisdiction.
 - 1. Prior to operation of permanent ventilation equipment for ventilation purposes during construction, Contractor shall verify that equipment is lubricated and filters are in place.
 - 2. Contractor shall provide and pay for maintenance and regular replacement of filters and worn or consumed parts of permanent ventilation system using for ventilation during construction.
 - 3. Immediately prior to Contract Completion review, Contractor shall change disposable filters and clean permanent filters of equipment used during construction.
 - 4. Contractor use of the equipment does not start the warrantee period. Refer to Specification section 01 78 33 for additional information.
- C. Ventilation Criteria: Ventilate enclosed areas to assist cure of materials, to dissipate humidity and to

prevent accumulation of dust, fumes, vapors and gases, as necessary for proper performance of the Work.

1.9 TEMPORARY WATER SERVICE

- A. Temporary Water Service: Contractor shall locate, with the assistance of the University, and connect to existing water source for temporary construction water service. Contractor shall comply with the following:
 - 1. Locate and connect to existing water source for temporary construction water service, as acceptable to University's Representative.
 - 2. Extend branch piping with outlets located, so that water is available by use of hoses.
 - 3. Temporary water service piping, valves, fittings and meters shall comply with requirements of the serving water utility and California Plumbing Code (CPC).
 - 4. All costs to establish temporary construction water system shall be included in the Contract Sum, or if so specified, costs shall be paid from Allowance specified in Section 01 21 00 - Allowance Procedures.
- B. Use of Permanent Water System: Permanent water system may be used for construction water after completion, sterilization, testing and inspection of system and approval by University's Representative and authorities having jurisdiction.
 - 1. Contractor use of the permanent water system does not start the warranty period. Refer to Specification section 01 78 33 for additional information.

1.10 TEMPORARY SANITARY FACILITIES

- A. Temporary Sanitary Facilities: Provide and maintain adequate temporary sanitary facilities and enclosures for use by construction personnel.
 - 1. Number of temporary toilets shall be suitable for number of workers.
 - 2. Provide wash-up sink with soap, towels and waste disposal.
- B. Use of Permanent Sanitary Facilities: Do not use permanent sanitary facilities unless approved by University's Representative. Immediately prior to Contract Completion review, thoroughly clean and sanitize permanent sanitary facilities used during construction.

1.11 TEMPORARY POWER AND LIGHTING

- A. Temporary Power and Lighting, General: Comply with NECA Electrical Design Library - Temporary Electrical Facilities.
- B. Temporary Power: Provide electric service as required for construction operations, with branch wiring and distribution boxes located to provide electrical service for performance of the Work.
 - 1. Provide temporary electric feeder connected to University operated electric utility service at

location determined by the Contractor and as approved by the University electric utility.

2. Temporary power conduit, raceways, fittings, conductors, panels, connections, disconnects, overcurrent protection, outlets and meters shall comply with requirements of the serving electric utility, California Electrical Code (CEC) and requirements of authorities having jurisdiction.
 3. Contractor shall pay all costs to establish temporary electric service, or if so specified, costs of temporary power shall be paid from Allowance specified in Section 01 21 00 - Allowance Procedures.
 4. As necessary in order to maintain construction progress, Contractor shall provide and pay all costs associated with generators used for temporary power.
- C. Temporary Lighting: Provide temporary lighting as necessary for proper performance of construction activities and for inspection of the Work.
1. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
 2. Maintain lighting and provide routine repairs.
- D. Protection: Provide weatherproof enclosures for power and lighting components as necessary. Provide overcurrent and ground-fault circuit protection, branch wiring and distribution boxes located to allow convenient and safe service about site of the Work. Provide flexible power cords as required.
- E. Use of Permanent Power and Lighting Systems: Permanent power and lighting systems may be used after completion, testing and inspection of systems and approval by University's Representative and authorities having jurisdiction.
1. Contractor shall maintain lighting and make routine repairs and replacements as necessary.
 2. Contractor shall pay for electricity consumed after permanent power system is operational and approved by authorities having jurisdiction.
- F. Service Disruptions: When necessary for energizing and de-energizing temporary electric power systems, minimize disruption of service to those served by public mains. Schedule transfers at times convenient to University and to occupants.
- G. Relamping: For permanent lighting used during construction, relamp all fixtures immediately prior to Contract Completion (punch list) review.

1.12 CONSTRUCTION TELEPHONE/DATA SERVICE

- A. Request and pay for telephone/data and fax facilities available for the duration of contract where the Contractor and its superintendent may be contacted.
- B. Connect to and use University's phone and internet system if required.
 1. If required, request and pay for phone/data installation through the Trustees Representative. Approximate costs are as follows:

- a. Tele/data lines to each trailer \$1,000 each
- b. Phone or Data connection \$ 85 each
- c. Telephone instrument \$ 350 each
2. Pay for phone sets, connection, data racks and servers and use costs.
3. Contractor will be billed directly for actual Telecommunications charges.
- C. Option: Use of cellular telephone, with Trustees Representative approval.
 1. Include voice message services. Contractor shall provide for cost of all services.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials: Contractor shall provide new materials. If acceptable to the Architect, undamaged previously used materials in serviceable condition may be used. Provide materials that are suitable for the use intended. Their use and methods of installation shall not create unsafe conditions or violate requirements of applicable codes and standards.
- B. Equipment: Contractor shall provide new equipment; or, if acceptable in writing by the Trustees, Contractor may provide undamaged, previously used equipment in serviceable condition. Provide equipment that is suitable for use intended.

PART 3 - EXECUTION

3.1 TEMPORARY UTILITIES INSTALLATION

- A. Temporary Utilities Installation, General: Contractor shall engage the appropriate local utility company or personnel to install temporary service or connect to existing service.
 1. Use Charges: Cost or use charges for temporary facilities are the Contractor's responsibility.
 2. Allowance for Utilities Charges: When Contract includes an allowance for metering of utility services, whether through temporary or permanent facilities, unused amount shall be returned to the Trustees by deductive change order.
- B. Water Service: Contractor may take water from the University's systems in such quantities and at such times as they are available. If this is done, Contractor shall provide all temporary materials necessary to extending the utility to where they will be used. Contractor shall install a meter and reimburse the University for any water used.
- C. Temporary Electric Power Service: Contractor may take electricity from the University's system if available. If this is done, Contractor shall provide all equipment, including connections, and other materials necessary for extending the utility lines to where they will be used. Contractor shall coordinate the installation with the University's Representative. Contractor shall install a meter and reimburse the University for any power used. Where sub-metering is not possible or practical, a flat fee may be established and paid to the University.
 1. When not available from the University, the Contractor must arrange and pay for electric service through the local utility or furnish his own portable power.

2. All permanent power used by the Contractor prior to Occupancy by the Trustees shall be metered and paid for by the Contractor.
- D. Temporary Telephones: Contractor shall have telephone facility available at its business office for the duration of contract where the Contractor and its superintendent may be contacted. A pay phone for use of subcontractors is recommended.
- E. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, Contractor shall install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Contractor shall comply with NFPA 10 "Standard for Portable Fire Extinguishers," and NFPA 241 "Standard for Safeguarding Construction, Alterations and Demolition Operations." Contractor shall:
1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near each usable stairwell.
 2. Store combustible materials in containers in fire-safe locations.
 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
 4. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.
- F. Maintenance of Temporary Utilities and Services: Contractor shall maintain temporary utilities and services in good operating condition until removal. Contractor shall protect from utilities and services from environmental and physical damage.

3.2 TERMINATION AND REMOVAL OF TEMPORARY UTILITIES AND SERVICES

- A. Termination and Removal of Temporary Utilities and Services: Unless the Trustees require that it be maintained longer, Contractor shall remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Completion. Contractor shall complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. At Completion, Contractor shall clean and renovate permanent facilities that have been used during the construction period.
- B. Removal of Temporary Underground Utilities and Restoration: Remove temporary underground utility installations to a minimum depth of two-feet below utility services. Contractor shall:
1. Backfill, compact and regrade site as necessary to restore areas or to prepare for indicated paving and landscaping.
 2. Restore paving damaged by temporary utilities. Refer to requirements specified in Section 01732 - Cutting and Patching Requirements.

- C. Cleaning and Repairs: Contractor shall clean exposed surfaces and repair damage caused by installation and use of temporary utilities and services. Where determined by University's Representative that repair of damage is unsatisfactory, Work, Contractor shall replace construction with matching finishes. Refer to requirements specified in Section 01 73 29 - Cutting and Patching Requirements.

END OF SECTION

SECTION 01 52 00 - CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Field offices and sheds.
- B. Removal of construction facilities.

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises.
- B. Section 01 51 00 - Temporary Utilities: Water, power and telephone services to construction facilities.
- C. Section 01 52 05 - Construction Staging Areas: Locations for field offices and sheds.
- D. Section 01 74 00 - Cleaning Requirements: Cleaning during construction and final cleaning.

1.4 MAINTENANCE OF CONSTRUCTION FACILITIES CONTROLS

- A. Maintenance: Contractor shall maintain construction facilities in proper and safe condition throughout progress of the Work.
- B. Replacement: In the event of loss or damage, Contractor shall promptly restore temporary construction facilities by repair or replacement at no change in the Contract Sum or Contract Time.

1.5 CONTRACTOR'S FIELD OFFICES AND SHEDS

- A. Contractor's Field Office: Contractor shall provide a mobile field office of weather-tight construction, with lighting, power, ventilation, heating and cooling to house Contractor. Unless otherwise indicated on the Drawings, Contractor shall locate field office at in staging area described in Section 01 52 05 - Construction Staging Areas. Contractor shall comply with University's requirements transmitted through University's Representative.
 - 1. Contractor shall provide temporary utilities to serve Contractor's field office. Refer to Section 01 51 00 - Temporary Utilities. Contractor shall connect to the University Telephone and Data service.
 - 2. Contractor's Field Office shall present neat, business-like appearance at all times, internally and

externally.

3. Contractor shall ensure that neither Contractor's Field Office nor other jobsite facilities are used for living quarters.
- B. Storage Sheds for Tools, Materials, and Equipment: Contractor shall provide weather-tight sheds, all with the following:
1. Heat and ventilation appropriate for storage of products requiring controlled conditions,
 2. Adequate space for organized storage and access, and
 3. Lighting for inspection of stored materials.
- C. Layout of Field Offices and Sheds: Within seven (7) calendar days of the Notice to Proceed, Contractor shall submit to University's Representative a proposed layout for field offices, sheds and storage areas. University's Representative will review and respond within seven (7) calendar days with comments and directions. Contractor shall comply with directions of University's Representative.

1.6 UNIVERSITY'S CONSTRUCTION MANAGEMENT FIELD OFFICE

- A. General: Contractor shall provide a field office for use by University's Inspector of Record and/or Construction Management team for the duration of the Contract, equipped and furnished as specified below. *A SINGLE CONSTRUCTION TRAILER MAY BE UTILIZED AND SHARED BETWEEN THE CONTRACTOR AND UNIVERSITY*
1. Contractor shall pay for all temporary water and power services, in accordance with Section 01 51 00 - Temporary Utilities.
 2. Contractor shall provide and pay for twice weekly cleaning services, including trash removal and restocking of toilet facility consumables. Contractor shall provide and pay for emptying sewage holding tank and related services on an as-needed basis, but not less frequently than each week.
 3. Contractor's initial progress payment for Work under the Contract will not be approved until University's Field Office is fully equipped and functional.
 4. Unless otherwise directed in writing by University's Representative, University's Field Office, including furnishings and equipment provided by Contractor, shall remain operational until execution or recording of Notice of Completion.
 5. With 14 days of written direction by University's Representative or within 14 days of execution or recording of Notice of Completion, whichever is earliest, Contractor shall take possession and remove University's Field Office from the campus.
 6. University's representatives shall have the right to use University's Construction Management Field Office, including furnishings and equipment, for the purpose of construction contract administration, testing and inspection for Work under this and any other contract, or other University business, at no change in Contract Sum and Contract Time.
- B. Construction: Contractor shall provide the following:

1. Field office of pre-fabricated, weather-tight construction, approximately 12 feet wide by 60 feet long, with lockable entrances, operable windows and serviceable finishes. Set field office on foundations suitable for normal office loadings, with tie-downs to resist wind and seismic forces. Provide field office of non-combustible construction where located within 30 feet of building lines. Comply with NFPA 241. Field office shall be capable of maintaining 68 to 78 degrees Fahrenheit interior year round.
 2. Field office with two exit doors, with cylinder locks and latch guards.
 3. Within field office, provide the following rooms:
 - a. Two private offices, approximately 120 square feet each.
 - b. Conference room of minimum 400 square feet.
 4. Private toilet facilities, complete with water closet, lavatory with hot and cold running water, medicine cabinet with mirror and dispensers for toilet paper and paper towels.
 5. Each private office and conference room with operable windows, at least one on each side equipped with blinds, insect screens.
 6. All plumbing, HVAC, power, lighting systems and telecommunications wiring and outlets as necessary for complete and habitable use.
 7. Properly configured, NEMA-polarized electrical outlets which prevent insertion of 110- to 120-volt plugs into higher-voltage outlets. Equip outlets with ground-fault circuit interrupters (GFCI), having reset button and pilot light in accordance with all applicable building codes.
 8. Ceiling-mounted fluorescent lighting fixtures, capable of providing uniform lighting of minimum 50 lumens at level 30-inches above floor.
 9. Provide heating and air conditioning unit mounted on end of trailer; of sufficient function, capacity and ductwork for equal distribution of air conditioning to all rooms. Roof-mounted units are not acceptable. Unit must be capable of maintaining 68 to 78 degrees F interior to year-round.
- C. Furnishings: Contractor shall provide the following furnishings.
1. Door mats: One per entrance, heavy-duty cocoa mat suitable for heavy use and removal of dirt and mud.
 2. Coat rack: Wall mounted, with shelf and hanging rod with twelve hangers.
 3. Folding tables: Four each 36-inches by 72-inches and two each 30-inches by 72-inches, heavy duty, with wood grain plastic laminate top.
 4. Folding chairs: Twelve each, heavy duty, with padded seats.
 5. Desks, per office: One each, 36-inches by 72-inches, double pedestal, painted steel with resilient writing surface top.

6. Desk chairs, per desk: One each, ergonomic design, heavy duty, wheeled pedestals, with adjustable back angle, seat angle and arm height.
 7. File cabinets: Four 4-drawer, legal-size vertical file cabinets, with lockable drawers.
 8. Bookcases: Four each, 84-inches high by 36-inches wide by 13-inches deep, with five adjustable shelves.
 9. Plan racks: Two each, factory-manufactured mobile stand by PlanHold or equal, with 24 removable drawing clamps each.
 10. Plan tables: Field-fabricated by Contractor, with top constructed from 35-inch by 84-inch solid core, 1-3/8 inch thick with tempered hardboard faces, and wood or steel support structure, located where directed by University's Representative.
 11. Markerboards: Four each, 36-inches wide by 48-inches high, with white markerboard suitable for oil- or water-base markers.
 12. Tackboards: Four each, 36-inches wide by 48-inches high, with wood fiberboard core and burlap grain vinyl facing, color as selected by University's Representative.
- D. Equipment: Contractor shall provide the following equipment. University shall be permitted to remove any equipment from field office and use elsewhere. All equipment shall be new and no substitutions or deviations from specified descriptions will be acceptable. Equipment will be returned by University prior to Contract close-out. At Contract close-out, University shall have option to purchase equipment at depreciated, fair-market value negotiated with Contractor.
1. Fire extinguisher: Portable, UL-listed and labeled, complying with NFPA 10 and NFPA 241 for classification, extinguishing agent and size as necessary for location and class of fire exposure, minimum UL Rating 4A-60BC (nominal 10 pound capacity).
 2. Drinking water: Containerized, hot and chilled water tap-dispenser with paper cup dispenser, with bottled water units and paper cup supply as necessary. Contractor shall provide weekly restocking of water and paper cups.
 3. Refrigerator: Minimum 3.2 cubic feet capacity, compact refrigerator with internal freezer compartment, white color.
 4. Microwave oven: Countertop design, white color.
 5. Coffee maker: One each, 12-cup capacity.
 6. Color printer/FAX/copier: One each, to be located in private offices, as manufactured by Hewlett-Packard, H-P OfficeJet Model G85 or current equivalent model, 3-year manufacturer's "Next Day Exchange" warranty, with black and tri-color ink cartridges. Contractor shall provide all consumables, including inkjet-suitable paper, for duration of Contract. Printer/fax/copier shall connect to personal computer and service printer for computer as well as fax machine and

copier.

7. Telecommunications:
 - a. Provide three (3) telecommunication lines minimum for each office, connected to campus network system.
 - b. Provide mounting backboard in a secure location for the Owner installation of a network distribution rack to campus system. Contractor shall make all final connections and label all jacks and cables according to the California State University Telecommunications Infrastructure Planning Standards (CSU TIPS). Standards may be found at the following web site, http://www.calstate.edu/cpdc/ae/gsf/TIP_Guidelines/, or may be obtained by written request.

- E. Miscellaneous: Contractor shall provide the following. University shall be permitted to remove any miscellaneous products from field office and for use elsewhere. All miscellaneous products shall be new and will be returned by University prior to Contract close-out. At Contract close-out, University shall have option to purchase miscellaneous products at depreciated, fair-market value negotiated with Contractor.
 1. Flashlights: Two each, MagLite tubular aluminum flashlights, for three D-size batteries. Include replacement batteries.
 2. First Aid Supplies: Comply with industrial safety regulations.

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONSTRUCTION FACILITIES

- A. Layout of Field Offices and Sheds: Within seven (7) calendar days of the Notice to Proceed, Contractor shall submit to University's Representative a proposed layout for field offices, sheds and storage areas. University's Representative will review and respond within five working days with comments and directions. Contractor shall comply with directions of University's Representative.
 1. Coordinate with requirements specified in Section 01 52 05 - Construction Staging Areas.
 2. Coordinate installation of construction fencing as specified in Section 01 56 00 - Temporary Barriers and Enclosures.

- B. Installation of University's Field Office: Provide field office ready for use within 20 working days of commencement date stated in Notice to Proceed or Notice of Award, whichever is earliest.

3.2 REMOVAL OF CONSTRUCTION FACILITIES

- A. Removal of Construction Facilities: Unless otherwise mutually agreed by University's Representative

and Contractor, remove temporary materials, equipment, services, and construction prior to Contract Completion review.

1. Coordinate removal with requirements specified in Section 01 51 00 - Temporary Utilities, Section 01 52 00 - Construction Facilities, Section 01 55 00 - Vehicular Access and Parking and Section 01 56 00 - Temporary Barriers and Enclosures.
 2. Completely remove in-ground construction facilities. Backfill, compact and regrade site as necessary to restore areas or to prepare for indicated paving and landscaping.
- B. Cleaning and Repairs: Clean and repair damage caused by installation or use of temporary construction facilities on public and private rights-of-way.

END OF SECTION

SECTION 01 52 05 - CONSTRUCTION STAGING AREAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Contractor Staging Area requirements.

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises.
- B. Section 01 52 00 - Construction Facilities: Field offices and sheds.
- C. Section 01 54 01 - Security
- D. Section 01 55 00 - Vehicular Access and Parking: Construction parking.
- E. Section 01 56 00 - Temporary Barriers and Enclosures: Temporary construction barriers, enclosures and passageways.
- F. Section 01 57 00 - Temporary Controls: Storm water pollution prevention measures; video record of existing conditions to be used to determine restoration Work.
- G. Section 01 58 00 - Project Identification and Signage: Directional and informational signage.
- H. Section 01 74 00 - Cleaning Requirements: Periodic cleaning and cleaning for Substantial Completion review.

1.4 SUBMITTALS

- A. Shop Drawings: Prior to site mobilization, Contractor shall prepare and submit for review by University's Representative a site plan indicating detailed layout of Contractor Staging Area, including:
1. Temporary utilities
 2. Temporary fencing and gates
 3. Temporary offices and sheds
 4. Construction aids
 5. Vehicular access ways, haul routes and on-site parking
 6. Temporary barriers and enclosures
 7. Storm water pollution prevention measures
 8. Fire department access impairment plan

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

3.1 CONTRACTOR STAGING AREA REQUIREMENTS

- A. Contractor Staging Areas: Refer to reference drawings included in the set of Contract Drawings for location of Contractor Staging Areas.
1. Contractor shall use only site areas designated specifically by University as Contractor Staging Area for the Project.
 2. Contractor Staging Area for the Project shall be clearly indicated by use of signage, delineators or other means acceptable to clearly identify the area. Contractor shall remove equipment placed or located outside of areas designated for Contractor Staging Area to within Contractor Staging Area at no change in Contract Time and Contract Sum.
 3. Contractor shall keep access to Contractor Staging Areas and other construction access ways and thoroughfares clear at all times. Contractor shall provide traffic and parking control signage acceptable to University's Representative.
 4. Contractor shall not impede access to/from any designated fire truck or emergency vehicle access lane at any time unless specifically granted by the University.
- B. Cleanliness: Contractor shall keep Contractor Staging Area clear of trash and debris and in neat order. Contractor shall be responsible for cleanliness and order of assigned Contractor Staging Areas, as

acceptable to University's Representative. Contractor shall clean and organize the area at no additional cost.

3.2 REMOVAL OF CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

- A. Removal of Construction Facilities and Temporary Controls: Unless otherwise mutually agreed by University's Representative and Contractor, Contractor shall remove temporary materials, equipment, services, and construction prior to Contract Completion review. Contractor shall coordinate removal with requirements specified in Section 01 51 00 - Temporary Utilities, Section 01 52 00 - Construction Facilities, Section 01 55 00 - Vehicular Access and Parking and Section 01 56 00 - Temporary Barriers and Enclosures.
- B. Cleaning and Repairs: Contractor shall clean and repair damage caused by installation or use of temporary facilities on public and private rights-of-way to the level of finish that was existing prior to the installation of temporary facilities. If there is no record of the prior condition, the finish shall be considered as new.
- C. Removal of Temporary Utilities and Restoration: Contractor shall remove temporary underground utility installations. Backfill, compact and regrade site as necessary to restore areas or to prepare for indicated paving and landscaping.

END OF SECTION

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SECTION 01 54 00 - CONSTRUCTION AIDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Construction aids, including but not limited to:
 - 1. Temporary lifts and hoists
 - 2. Debris chutes
 - 3. Temporary stairs
 - 4. Scaffolding

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises
- B. Section 01 56 00 - Temporary Barriers and Enclosures: Temporary construction barriers, enclosures and passageways
- C. [Section 14 21 00 - Electric Traction Elevators:] [Section 14 24 00 - Hydraulic Elevators:] Use of building elevators for construction activities.

1.4 CODES AND REGULATIONS

- A. Safety Regulations: Contractor shall comply with requirements of all applicable Federal, State and local safety rules and regulations. Contractor shall be solely responsible for jobsite safety.

1.5 TEMPORARY LIFTS AND HOISTS

- A. Temporary Lifts and Hoists: Contractor shall provide facilities for hoisting materials and personnel. Mobile lifts and truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- B. Temporary Elevator Usage: [Refer to [Section 14 21 00 - Electric Traction Elevators] [Section 14 24 00 - Hydraulic Elevators] for use of building elevator[s] during construction.
 - 1. Contractor shall provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame.

2. Contractor shall clean and restore elevator cars used during construction.
3. If, despite such protection, elevators become damaged, Contractor shall engage (and Contract Sum shall include) elevator Installer to restore damaged work so no evidence remains of correction Work.
4. Contractor shall return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

1.6 DEBRIS CHUTES

- A. Debris Chutes: Contractor shall provide chutes as necessary for debris removal. Contractor shall:
1. Construct debris chutes of substantial materials. Use cylindrical, laminated fiber forms (Sonotube[®] or equal) to minimize noise of debris removal.
 2. Provide controls at debris chutes to minimize spread of dust and debris.
 3. Limit use of debris chutes to times to minimize disruption of activities in adjacent spaces.

1.7 TEMPORARY STAIRS AND SCAFFOLDING

- A. Temporary Stairs: Until permanent stairs are available, Contractor shall provide temporary stairs where ladders are not adequate. Contractor shall cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of Contract Completion review.
- B. Permanent Stair Usage: Use of permanent stairs will be permitted, as long as Contractor cleans and maintains stairs in a condition acceptable to University's Representative.
1. Contractor shall provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress.
 2. If, despite such protection, stairs become damaged, Contractor shall restore damaged areas as acceptable to University's Representative.
 3. Contractor shall coordinate usage of existing stairs at occupied facilities with University's Representative.
- C. Scaffolding: Contractor shall provide scaffolding as necessary for access and proper performance of the Work. Design and installation of scaffolding shall be solely Contractor's responsibility.

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

3.1 MAINTENANCE OF CONSTRUCTION AIDS

CONSTRUCTION AIDS

- A. Maintenance: Contractor shall use all means necessary to maintain construction aids in proper and safe condition throughout progress of the Work.
- B. Replacement: In the event of loss or damage, Contractor shall promptly restore construction aids by repair or replacement at no change in the Contract Sum or Contract Time.

3.2 REMOVAL OF CONSTRUCTION AIDS

- A. Removal of Construction Aids: Unless otherwise mutually agreed by University's Representative and Contractor, Contractor shall remove construction aids prior to Contract Completion review. Contractor shall coordinate removal with requirements specified in Section 01 51 00 - Temporary Utilities, Section 01 52 00 - Construction Facilities, Section 01 55 00 - Vehicular Access and Parking and Section 01 56 00 - Temporary Barriers and Enclosures.
- B. Cleaning and Repairs: Contractor shall clean and repair damage caused by installation or use of construction aids.

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SECTION 01 55 00 - VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Requirements for vehicular access to Work areas
- B. Requirements for construction parking

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises.
- B. Section 01 52 00 - Construction Facilities: Coordination of access to field offices and sheds.
- C. Section 01 52 05 - Construction Staging Areas: Layout of construction staging area, including locations for vehicular access and construction parking.
- D. Section 01 56 00 - Temporary Barriers and Enclosures: Requirements for temporary construction barriers, enclosures and passageways, applicable to construction parking areas.
- E. Section 01 58 00 - Project Identification and Signage: Directional and informational signage.
- F. Section 01 57 00 - Temporary Controls: Storm water pollution prevention measures; video record of existing conditions to be used to determine restoration Work.
- G. Section 01 74 00 - Cleaning Requirements: Cleaning during construction and final cleaning.

1.4 PROTECTION OF EXISTING CONDITIONS

- A. Protection of Adjacent Facilities: Contractor shall restrict Work to limits indicated on the Drawings and as specified in Section 01 11 00 - Summary of the Work. Contractor shall protect existing, adjacent facilities from damage, including soiling and debris accumulation.

1.5 SITE ACCESS

- A. Site Access: Use of designated existing on-site streets and driveways for construction traffic is permitted. Contractor shall review access routes with University Representative and comply with University Representative's directions.
 - 1. Contractor shall ensure that tracked vehicles shall not use paved areas.
 - 2. Contractor shall provide unimpeded access for emergency vehicles. Contractor shall maintain 20-foot (6 m) width driveways with turning space between and around combustible materials.
 - 3. Contractor shall provide and maintain access to fire hydrants free of obstructions.

4. Contractor shall clean and restore paving and other site features after construction use.

B. Traffic Control:

1. Contractor shall comply with all on-campus traffic regulations, including speed limits. Contractor shall pay all parking and traffic fines.
2. Blockage of site roadways and access to site parking lots and parking structures shall be only with approval of University's Representative. Contractor shall comply with University's restrictions on blocking roadways and parking areas.
3. Contractor shall employ a minimum of two (2) trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on vehicular and pedestrian traffic lanes.
4. Contractor shall provide signage, cones and other suitable devices to direct traffic. Contractor shall use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
5. Large vehicles shall have University public safety escort. Contractor shall provide minimum 48 hours written notice through University Representative.
6. Contractor shall submit a detailed traffic management plan to the University for review and approval fourteen (14) days minimum before any required full road closure and seven (7) days' notice prior to any single lane closures. Traffic plan shall clearly indicate vehicle, bicycle and pedestrian paths.

1.6 TRAFFIC SIGNS AND SIGNALS

- A. Traffic Signs and Signals: Contractor shall provide temporary signs and signals as required by authorities having jurisdiction and in compliance with University's requirements transmitted through University Representative. Contractor shall relocate signs and signals as necessary during construction.

1.7 CONSTRUCTION PARKING

A. Construction Parking:

1. Contractor shall not park on public roadways unless approved by campus police and fire authorities.
2. Contractor shall maintain clear access ways and parking for emergency vehicles, as required by campus police and fire authorities.
3. Contractor shall provide on-site parking for construction purposes.
4. Contractor shall obtain and pay for parking permits for on-campus parking, including use permits for campus parking lots and for parking on the construction site itself. This requirements does not apply to construction equipment (fork lifts, excavators, backhoes cranes, etcetera)
 - a. General Parking: Any vehicle parked on campus not actively used to carry tools, equipment, and supplies must display a valid general permit.
 1. Fee: Current rate for General Daily, Weekly or Quarterly. For more information on general parking rules, regulations and rates visit

<https://afd.calpoly.edu/parking/parkingoncampus/permits/general.php> or
contact the University Representative.

2. Replacement fee: Equivalent to current General rate.
 3. Sold/Issued through University Police, Bldg. #036.
- b. Construction Area – Designated parking within the construction site or undesignated parking near project buildings or work area (sidewalks, greenbelts, dirt area).
1. Fee: \$10.00 per permit flat rate (cost subject to change).
 2. Duration: 6 months.
 3. Replacement rate: \$10.00 (cost subject to change).
 4. Rate for projects less than (4) days charged Daily General permit rate.
 5. Limited number of permits available for parking during project hours; number to be determined by University Representative and provided to University Police.
 6. Limited to work trucks with tools, equipment, and supplies.
 7. Issued through University Representative.
- c. Depending on lot availability, Contractor may rent lay down area for field office and/or staging. Contractor(s) requiring lay down area(s) will make this request through the University Representative. If approved Contractor will enter into a rental agreement with University Police/Parking Services. Rates are based on proximity to the campus core and academic term, but will not exceed the current Residential permit rate per space/space equivalent.

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

3.1 MAINTENANCE OF PARKING AND ACCESS ROADS

- A. Maintenance: Contractor shall maintain traffic and parking areas in a sound condition. Contractor shall repair breaks, potholes, low areas, standing water and other deficiencies, to maintain paving and drainage in original or specified condition.
- B. Cleaning of Roadways and Parking Areas: Contractor shall keep public and private rights-of-way and parking areas clear of construction-caused soiling, dust and debris, especially debris hazardous to vehicle tires. Contractor shall perform cleaning as frequently as necessary. Contractor shall coordinate with requirements specified in Section 01 57 00 - Temporary Controls and Section 01 74 00 - Cleaning Requirements.

END OF SECTION

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SECTION 01 56 00 - TEMPORARY BARRIERS AND ENCLOSURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Temporary construction barriers, enclosures and passageways.
 - 1. Dust and debris barriers.
 - 2. Security barriers
 - 3. Temporary chain link fencing.
 - 4. Covered passageways.
 - 5. Protection of completed Work.
- B. Removal of construction facilities and temporary controls.

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises
- B. Section 01 51 00 – Temporary Utilities: Temporary sanitary facilities, power and lighting
- C. Section 01 52 00 – Construction Facilities: Installation of Construction Facilities
- D. Section 01 52 05 - Construction Staging Areas: Submittals, staging and removal
- E. Section 01 54 00 – Construction Aids: Temporary lifts, hoists, stairs, scaffolding
- F. Section 01 54 01 - Security
- G. Section 01 55 00 - Vehicular Access and Parking: Construction parking restrictions
- H. Section 01 56 39 - Tree and Plant Protection: Requirements for barriers and covers at existing trees, shrubs and ground covers
- I. Section 01 57 00 - Temporary Controls: General requirements for protection of existing conditions and run-off control
- J. Section 01 58 00 - Project Identification and Signage: Directional and informational signage.

1.4 CODES AND REGULATIONS

- A. California Building Code (CBC): Comply with California Building Code (CBC) Chapter 33, Section 3303, Protection of Pedestrians During Construction or Demolition.
- B. Fire Regulations: Comply with requirements of fire authorities having jurisdiction, including California Fire Code (CFC) Article 87 during performance of the Work.

- C. Safety Regulations: Comply with requirements of all applicable Federal, State and local safety rules and regulations. Contractor shall be solely responsible for jobsite safety.
- D. Barricades and Barriers: As required by governing authorities having jurisdiction, provide substantial barriers, guardrails and enclosures around Work areas and adjacent to embankments and excavations for protection of workers and the public.
 - 1. In and around existing facilities, walkways or thoroughfares where the public must exit, use or otherwise occupy, provide and submit to the University an impairment plan. This plan shall define the pathways to be protected and maintained and shall consider egress occupant load. Contractor shall coordinate with the University for specific conditions.

1.5 PROTECTION OF EXISTING CONDITIONS

- A. Protection of Adjacent Facilities: Contractor shall restrict Work to limits indicated on the Drawings and as specified in Section 01 11 00 - Summary of the Work: Protect existing, adjacent facilities from damage, including soiling and debris accumulation.
- B. Protection of Existing Furniture, Fixtures and Equipment: As applicable, provide temporary enclosures, barriers and covers to protect existing furniture, fixtures and equipment remaining in Project area during construction.

1.6 MAINTENANCE OF CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

- A. Maintenance: Use all means necessary to maintain temporary barriers and enclosures in proper and safe condition throughout progress of the Work, including all non-working times such as nights, holidays and weekends.
- B. Replacement: In the event of loss or damage, promptly restore temporary barriers and enclosures by repair or replacement at no change in the Contract Sum or Contract Time.

1.7 TEMPORARY BARRIERS, ENCLOSURES AND PASSAGEWAYS

- A. Temporary Barriers, General: Provide temporary fencing, barriers and guardrails as necessary to provide for public safety, to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.
 - 1. Refer to temporary fencing and phasing plan in the Drawings. Comply with requirements indicated.
 - 2. Note requirements for continued occupancy and use of existing buildings and site areas during construction.
 - 3. Comply with applicable requirements of California Building Code (CBC) and authorities having jurisdiction, including industrial safety regulations. Review requirements with University's Representative.
 - 4. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for firefighting.
 - 5. Paint temporary barriers and enclosures with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard.

6. Where appropriate and necessary, provide pedestrian lighting (1cd minimum) warning lighting, including flashing red or amber lights.
- B. Temporary Chain-Link Fencing: Provide temporary portable chain-link fencing with windscreen. See Section 01 52 05 – Construction Staging Area for requirements for layout of fencing.
1. Portable Chain-Link Fencing: Minimum 2-inches (50-mm) 11-gauge, galvanized steel, chain-link fabric fencing; minimum 6-feet (2.4 m) high with galvanized steel pipe posts; minimum 2-3/8-inches- (60-mm-) OD line posts and 2-7/8-inches- (73-mm-) OD corner and pull posts, with 1-5/8-inches- (42-mm-) OD top and bottom rails.
 - a. Provide concrete or galvanized steel bases for supporting posts.
 - b. Provide protective barriers at bases to prevent tripping by pedestrians or wind. Where required, install ground mounted posts or other means to prevent the fence from tipping.
 2. Windscreen on Chain-Link Fencing: For screening of construction activities from view, equivalent to the following:
 - a. Specified manufacturer: None identified. Equivalent products of other manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 61 00 - Basic Product Requirements.
 - b. Acceptable manufacturers: None identified. Equivalent products of other manufacturers will be considered in accordance with the "or equal" provision specified in Section 01 61 00 - Basic Product Requirements.
 - c. Windscreen fabric: Closed mesh weave of 30 warp by 16 fills per square inch.
 - 1) Fiber: 5.6 ounce per square yard polypropylene fiber.
 - 2) Shade factor: 78 percent.
 - 3) Tensile strength: 360 pounds for warp and 190 pounds for fill, when tested according to ASTM D1682, grab method.
 - 4) Tear strength: 110 pounds for warp and 70 pounds for fill, when tested according to ASTM D2263, trapezoidal method.
 - 5) Color: Green
 - d. Fabric Fabrication:
 - 1) Reinforce hems and seams with 2-3/4 inch black polypropylene folded binding tape, with tensile strength of 300 pounds.
 - 2) Provide center reinforcing tape in addition to reinforced perimeter hems and panel seams.
 - 3) Sew hems and seams with UV light resistant polyester thread.
 - 4) Provide 9/32-inch brass grommets spaced at 12-inches on center in perimeter hems and center reinforcing tape.
 - e. Secure windscreen to fence at all grommets.

- f. Locate windscreen on prevailing windward side of fence. Where prevailing wind direction cannot be determined, install fabric on the outside of fence.
 - g. **Do not cut the fabric to relieve wind pressure.** Install ground mounted posts or other means to prevent tipping.
- C. Tarpaulins: Fire-resistive labeled with flame-spread rating of 15 or less.
- D. Covered Passageways: Erect a structurally adequate, protective, covered walkways for passage of persons along adjacent passageways.
 - 1. Coordinate installation details with University's requirements for continuing operations in adjoining facilities.
 - 2. Review design and details with University's Representative.
 - 3. Comply with applicable regulations of authorities having jurisdiction.
 - 4. Construct covered walkways using scaffold or shoring framing.
 - 5. Provide wood-plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 - 6. Extend back wall beyond the structure to complete enclosure fence.
 - 7. Paint and maintain in a manner as directed by University's Representative.
- E. Temporary Wood Fencing: Erect a structurally adequate, protective wood fencing in compliance with California Building Code (CBC) Chapter 33, Section 3303.7 - Pedestrian Protection. Wood fencing shall be provided as required by Table 33-A.
 - 1. Materials: As required by CBC Section 3303.7.
 - 2. Finishes: As acceptable to University's Representative. Fence where exposed to public view shall receive minimum of one coat wood primer and one coat semi-gloss paint, color(s) as directed by University's Representative.
- F. Temporary Closures: Provide temporary closures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather-tight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate closures with ventilating and material drying or curing requirements to avoid dangerous conditions and effects such as mold.
 - 2. Vertical openings: Close openings of 25 sq. ft. (2.3 sq. m) or less with plywood or similar materials.
 - 3. Horizontal openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
 - 4. Install tarpaulins securely using wood framing and other suitable materials.
 - 5. Where temporary wood or plywood enclosure exceeds 100 sq. ft. (9.2 sq. m) in area, use fire-retardant-treated material for framing and main sheathing.

- G. Temporary Partitions: Erect and maintain temporary partitions and temporary closures to limit dust and dirt migration, including migration into existing facilities, to separate areas from fumes and noise and to maintain fire-rated separations.
- H. HVAC Protection: Provide dust barriers at HVAC return grilles and air inlets to prevent spread of dust and clogging of filters. Notify University Representative of all HVAC register barriers. If existing HVAC system is required to maintain proper temperature, refer to specification section 01 55 00, Temporary Utilities.
- I. Temporary Floor Protection: Protect existing floors from soiling and damage.
 - 1. Cover floor with 2 layers of 3-mil (0.07-mm) polyethylene sheets, extending sheets 18 inches (460 mm) up walls.
 - 2. Cover polyethylene sheets with 3/4-inch (19-mm) fire-retardant plywood.
 - 3. Provide floor mats to clean dust from shoes.
 - 4. Other methods may be acceptable by written request and approval of the University Representative.
- J. Landscape Barriers: Provide barriers around trees and plants designated to remain. Coordinate with requirements specified in Section 01 56 39 - Tree and Plant Protection.
 - 1. Locate barriers as directed outside of drip lines of trees and plants.
 - 2. Protect entire area under trees against vehicular traffic, stored materials, dumping, chemically injurious materials, and puddling or continuous running water.
 - 3. Contractor shall pay all costs to restore trees and plants within barriers that are damaged by construction activities. Restoration shall include replacement with plant materials of equal quality and size. Costs shall include all fines, if any, levied by authorities having jurisdiction.
- K. Barricades, Warning Signs and Lights, General: Comply with standards and code requirements for erection of structurally adequate barricades. Paint or utilize barricades with appropriate colors, graphics and warning signs to inform personnel and the public when protecting them against a hazard. Where appropriate and needed provide lighting, including flashing red or amber lights.
- L. Guard Rails: Provide guard rails along tops of embankments and excavations. Along public walkways and areas accessible by the public, adjoining excavations, provide guardrails in addition to fencing.
 - 1. Guardrails shall be substantially and durably constructed of lumber, firmly anchored by posts embedded in concrete, and complying with Code requirements for temporary barriers.
 - 2. Guardrails shall comply with dimensional requirements and accommodate loads as prescribed by California Building Code (CBC) for permanent guardrails.
- M. Security Closures and Lockup: Provide substantial temporary closures of openings in exterior surfaces and interior areas as appropriate to prevent unauthorized entrance, vandalism, theft and similar violations of security. Provide doors with self-closing hardware and locks.

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1. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- N. Weather Closures: Provide temporary weather-tight closures at exterior openings to prevent intrusion of water, to create acceptable working conditions, to protect completed Work and to maintain temporary heating, cooling and ventilation. Provide access doors with self-closing hardware and locks.
- O. Temporary Access, Passage and Exit Ways: Construct temporary stairs, ramps, and covered walkways, with related doors, gates, closures, guardrails, handrails, lighting and protective devices, to maintain access and exit ways to existing facilities to remain operational.
1. Design and location of temporary construction shall be by Contractor, subject to review by University's Representative and authorities having jurisdiction.
 2. Provide temporary lighting, illuminated interior exit signage, non-illuminated directional and instructional signage, and temporary security alarms for temporary exits and exit passageways.
 3. Temporary measures shall suit and connect to existing building systems, and shall be approved by University's Representative and authorities having jurisdiction.

1.8 PROTECTION OF INSTALLED WORK

- A. Protection of Installed Work, General: Provide temporary protection for installed products. Control traffic in immediate area to minimize damage.
- B. Protective Coverings: Provide protective coverings at walls, projections, jambs, sills, and soffits of openings as necessary to prevent damage from construction activities, such as coatings applications, and as necessary to prevent other than normal atmospheric soiling.
- C. Traffic Protection:
1. Protect finished floors, stairs and other surfaces from traffic, soiling, wear and marring.
 2. Provide temporary covers of plywood, reinforced kraft paper or temporary rugs and mats, as necessary. Temporary covers shall not slip or tear under normal use.
 3. Prohibit traffic and storage on waterproofed and roofed surfaces and on landscaped areas.
 4. Protect newly fine graded, seeded and planted areas with barriers and flags to designate such areas as closed to pedestrian and vehicular traffic.

1.9 REMOVAL OF TEMPORARY BARRIERS AND ENCLOSURES

- A. Removal of Temporary Barriers and Enclosures: Unless otherwise mutually agreed by University's Representative and Contractor, remove temporary materials, equipment, services, and construction prior to Contract Completion review. Coordinate removal with requirements specified in Section 01 51 00 - Temporary Utilities, Section 01 52 00 - Construction Facilities and Section 01 55 00 - Vehicular Access and Parking.
- B. Cleaning and Repairs: Clean and repair damage, soiling and marring caused by installation or use of temporary barriers and enclosures.

PART 2 PRODUCTS (not applicable to this section)

PART 3 PART 1 – EXECUTION (not applicable to this section)

END OF SECTION

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Requirements for protection of existing landscape plant materials, including trees, shrubs and ground covers. Contractor shall preserve, protect, and prune as necessary existing trees and shrubs, and other vegetation indicated to remain.

1.3 RELATED SECTIONS

- A. Section 01 56 00 – Temporary Barriers and Enclosures: Barricades and barriers used to protect landscaping.
- B. Section 01 57 00 – Temporary Controls: Runoff.
- C. Division 2 - Site Construction: Landscaping specifications related to trees, shrubs and ground covers, as applicable.

1.4 WORK DESCRIPTION

- A. Protection: All trees and plant materials to remain on site shall be protected from construction activities. Preserve, protect, and prune as necessary existing trees and shrubs and other vegetation indicated to remain.
- B. Maintenance: Until Contract closeout, Contractor shall irrigate, fertilize, prune and clean as necessary to maintain all existing trees, shrubs and ground covers in healthy condition, within and adjacent to Project area.

1.5 DEFINITIONS

- A. "Injury" is defined, without limitation, as any bruising, scarring, tearing, or breaking of roots, branches, or trunk.
- B. "Dripline" is defined as the outermost limits of the tree or shrub canopy.
- C. "Certified Arborist" is a consulting arborist certified by the International Society of Arboriculture, current certification in effect.

1.6 QUALITY ASSURANCE

- A. General Responsibility: The Contractor shall be directly responsible for protection and welfare of existing trees within the Contract Limits which are noted to remain. This responsibility shall

continue throughout the full construction period until the entire project is completed and accepted by the University's Representative and through completion of the guarantee period.

- B. Qualifications of workmen: Trimming shall be performed only by a licensed arborist. Provide at least one person approved by the University's Representative who shall be present at all times during tree protection and trimming operations, who shall be thoroughly familiar with the type of work involved, and who shall direct all protection and trimming work.
- C. Reference Standards: Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of this section.
 - 1. International Society of Arboriculture (ISA) "Guide for Plant Appraisal" prepared by the Council of Tree and Landscape Appraisers (CTLA).
 - 2. "Cabling, Bracing and Guying Standards for Shade Trees", as published by the National Arborist Association (NAA), 174 TR 101, Bedford, New Hampshire.
 - 3. ANSI A-300, Standards for Tree care Operations – Tree, Shrub, and Other Woody Plant Maintenance:
 - Part 1 – Pruning, 2008.
 - Part 2 – Fertilization, 2004.
 - Part 3 – Supplemental Support Systems, 2006.
- D. Sequencing Schedule: Coordinate and cooperate with other trades to enable the work to proceed as rapidly and efficiently as possible.

1.6 PRE: CONSTRUCTION MEETING:

- A. Prior to construction of any nature on the site, Contractor shall arrange a site meeting with the University's Representative. The purpose of the meeting shall be to establish the conditions of all existing plant material to be preserved upon receipt of the site by the Contractor. Failure to call for said meeting implies acceptance by the Contractor of plant material to be preserved in its existing condition.
 - 1. Contractor shall document condition of all existing plant material to be preserved by means of individual color photos for each tree or plant to be preserved.
 - a. Photos shall be labeled with plant botanical and common names, location on site, and date of photograph.
 - b. Photos shall clearly indicate condition of tree or plant to be retained.
 - 2. Submit photographs to University for approval.

1.7 SUBMITTALS

- A. Submittal procedures are specified in Division 1. Provide a minimum of four copies unless otherwise directed.
- B. Provide the following submittals for review and approval:
 - 1. Pruning materials.
 - 2. Fencing materials.
 - 3. Maintenance plan.
 - 4. Photo documentation of existing plant material.

1.8 GUARANTEE

- A. Contractor shall guarantee that all plants covered by the provisions of this Section will be healthy and in flourishing condition of active growth 1 year from the date of Final Completion.
- B. During the warranty period the Contractor shall be liable for damages to all trees covered by the provisions of this Section, and shall pay compensation to the University as specified herein.
- C. Contractor will not be held responsible for damages due to vandalism or acts of nature during the guarantee period. Immediately report such conditions to the University's Representative.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCING

- A. Tree Protection Fence:
 - 1. Fencing Materials - 11 gauge galvanized 6' high chain-link fence with galvanized steel posts at 10' on center maximum.
 - 2. Provide padlocked gate access to inside for care of tree.
 - 3. Fence shall be sturdy and capable of acting as a barrier against objects, vehicles, etc., and designed so as to allow for relocations as required. It shall be continuously maintained and repaired as necessary.

2.2 PRUNING MATERIALS

- A. Pruning materials shall be in accordance with current horticultural practices.

PART 3 – EXECUTION

3.1 PLANT MATERIAL PROTECTION

- A. Protect existing plant material specified on the drawings during course of construction and maintenance period in a healthful state, free from damage or harm as the result of any work performed.
 - 1. Protection shall be given to the roots, trunk, and foliage.
 - 2. Plants shall not be allowed to deteriorate and shall be maintained in a healthy and vigorous condition.
- B. Protect trees and plant materials to remain from trades working on site.
 - 1. Insure that subcontractors are aware of and held responsible for damage to existing trees and plant material.
 - 2. Insure that protective measures are carried out continually throughout the construction period.
- C. Contractor is responsible for replacing damaged plant life with approved equivalent.
- D. Water: Provide ample water supply of potable quality and sufficient quantity for all operations required under this Section.

- E. Trees and plants, subject to the provisions of this Section, which have been injured shall be repaired immediately under the direction of an approved arborist. Repair shall include removal of rough edges and sprung bark and severely injured branches as directed by the University's Representative.
- F. The Contractor shall maintain healthy living conditions for existing plant materials to be preserved.
 - 1. Such measures shall include monthly washing of leaves for the removal of dust, regular irrigation, root feeding, etc.
- G. Install tree protection fencing as specified elsewhere in this section.
- H. Drainage:
 - 1. During construction, the existing site surface drainage patterns shall not be altered within the area of the drip line of existing plant materials.
 - 2. Contractor shall not alter the existing water table within the area of the drip line of existing plant materials.
- I. Do not permit any of the following within drip line of any existing tree or shrub to be preserved:
 - 1. Storage or parking of automobiles or other vehicles.
 - 2. Stockpiling of building materials or refuse of excavated materials.
 - 3. Skinning or bruising of bark.
 - 4. Use of trees as support posts, power poles, or signposts; anchorage for ropes, guy wires, or power lines; or other similar functions.
 - 5. Dumping of poisonous materials on or around trees and roots. Such material includes but is not limited to paint, petroleum products, contaminated water, or other deleterious materials.
 - 6. Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches, and other miscellaneous excavation without prior written approval by the University's Representative.
 - 7. Damage to trunk, limbs, or foliage caused by maneuvering vehicles or stacking material or equipment too close to the tree.
 - 8. Compaction of the root area by movement of trucks or grading machines; storage of equipment, gravel, earth fill, or construction supplies; etc.
 - 9. Excessive water or heat from equipment, utility line construction, or burning of trash under or near shrubs or trees.
 - 10. Damage to root system from flooding, erosion, and excessive wetting and drying resulting from dewatering and other operations.

3.2 TREE PROTECTION FENCING

- A. Install tree protection fencing around trees to be preserved with a caliper of 4" or larger, unless otherwise noted on plans.
 - 1. Install fencing at the dripline unless otherwise approved by the University's Representative.
 - 2. Fence can be erected around groups of adjacent trees where possible.
 - 3. Otherwise, fence to be erected around individual trees.

- B. No construction, demolition, or work of any nature will be allowed within the fenced area without prior written approval by the University's Representative.
 - 1. Approval by the University's Representative for work within the fenced area shall not release the Contractor from any of the provisions specified herein for the protection of existing trees and plants to be preserved.
 - 2. During the course of construction of approved work within the fence area, no roots shall be cut without prior written approval by the University's Representative.
- C. During the course of construction, relocation of the fence may be required to facilitate construction. The Contractor shall do so when authorized and as directed by the University's Representative, at no additional expense to the University.
- D. The fence shall be removed only at the end of construction, as approved by the University's Representative.

3.3 TEMPORARY IRRIGATION:

- A. Irrigate existing trees and other plants to remain, as necessary to maintain their health before, during and after Work under the Contract, as directed by the University's Representative.
 - 1. Maintain an irrigation schedule and document. Submit schedule to University's Representative for review and acceptance.
 - 2. Provide temporary piping, valves, hoses, emitters and spray heads as necessary until Contract closeout.
- B. Soil Preparation: If soil within drip line of trees is compacted, then prior to watering or fertilizing trees, area within the drip lines shall be tilled to break up the top two inches of existing soil.

3.4 EXCAVATION AROUND TREES AND PLANTS:

- A. Excavation within the drip lines of trees and plants to be preserved shall be done only where absolutely necessary, under the direction of a Certified Arborist and with prior approval from the University's Representative.
- B. Where trenching for utilities is required within driplines, tunneling under and around roots shall be by hand digging. Main lateral roots and taproots shall not be cut. Smaller roots that interfere with installation of new work may be cut with prior approval from certified Arborist.
- C. Where excavation of new construction is required within drip line of trees, hand excavation shall be employed to minimize damage to root system. Roots shall be relocated in backfill areas wherever possible. If large, main lateral roots are encountered, they shall be exposed beyond excavation limits as required to bend, and relocate without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical, roots shall be cut approximately 6 inches back from new construction under the direction of a certified Arborist.
- D. Exposed roots shall not be allowed to dry out before permanent backfill is placed. Temporary earth cover shall be provided, or roots shall be packed with wet peat moss or four layers of

wet, untreated burlap and temporarily supported and protected from damage until permanently relocated and covered with backfill. The cover over the roots shall be wetted to the point of runoff daily.

- E. Branching structure shall be thinned in accordance with National Arborists Association "Pruning Standards and Principles" to balance loss of root system caused by damage or cutting of root system. Thinning shall not exceed 30 percent of existing branching structure.

3.5 TREE TRIMMING

- A. If tree trimming is necessary to protect the health of the tree, as determined by the University Representative, or if required to clear for construction, it shall be done only under the direction of a Certified Arborist engaged at the Contractor's expense.
- B. In company with the University's Representative, University and the Arborist, ascertain the limbs and roots which are to be trimmed. Clearly mark them to designate the approved point of cutting.
- C. Dead and damaged trees that are determined by the Certified Arborist to be incapable of restoration to normal growth pattern shall be removed.
- D. Cut evenly, using proper tools and skilled workmen, to achieve neat severance with the least possible damage to the tree.
- E. In the case of root cuts, apply wet burlap or other protection, approved as noted herein, to prevent drying out, and maintain in a wet condition as long as necessary for temporary protection.

3.6 REPAIR COMPENSATION

- A. Damage:
 - 1. Damage to existing tree crowns or roots over 1" in diameter shall be immediately reported to the University's Representative in writing.
 - 2. A Certified Arborist shall direct all repairs to trees damaged by construction operations. Repairs shall be made promptly after damage occurs to prevent progressive deterioration of damaged trees. Repairs shall be at the Contractor's expense.
- B. Irreparable Damage: Any tree to be protected which is irreparably damaged owing to the Contractor's negligence or failure to provide adequate protection shall be compensated for in accordance with the following schedule of values using the "tree caliper" method (greatest trunk diameter, measured 18 inches above the ground):
 - 1. For trees with diameters up to and including 6 inches, compensation shall be the actual cost of replacement with item similar in species, size, and shape, including:
 - a. Actual cost of item boxed out of the ground.
 - b. Transportation or delivery of boxed item to site.
 - c. Planting and staking.
 - d. Maintenance, including watering, fertilizing, pruning, pest control, and other care to bring replacement to same general condition of original item.
 - 2. For trunks up to:
 - 7" \$ 1,200

8"	1,700
9"	2,200
10"	2,600
11"	3,100
12"	3,600
13"	4,100
14"	4,600
15"	5,000
16"	5,500
17"	6,000
18" and over, add for each caliper inch ...	\$600

- C. Damaged tree limbs or trees which have died as a result of injury during construction shall remain the property of the University and shall remain or be removed by the Contractor as directed by the University's Representative.

3.7 MAINTENANCE

- A. Contractor shall be responsible to perform periodic inspections of existing trees and shrubs to be preserved and submit written proposals to the University's Representative for additional maintenance work as may be required to ensure the health and general well-being of the trees.
 - 1. Contractor shall retain, at the direction of the University's Representative additional specialists as may be required to perform this work.
 - 2. The maintenance and quality of the plant materials shall be subject to monthly checks by the University. The dates of these checks shall be outlined in the University's Representative's field notification relating to the establishment of the plant maintenance period. Additional checks shall be scheduled as determined by the University's Representative.
- B. Plant material must be maintained throughout the duration of the construction period in a healthful manner. Plant material identified which requires special pruning, insect control, fertilization or other remedial health action will be treated during this period. Methods and rates of pesticide and fertilizer application will be reviewed by the University's Representative prior to approval.
- C. Tree Basins and Mulching:
 - 1. Construct tree basins at base of existing trees to be preserved so that applied water will remain on top of the root-ball. Size of basin shall be as recommended by the arborist.
 - 2. Tree basins shall be mulched with 1-inch neutralized fir bark.
- D. Watering:
 - 1. Plant materials shall be watered on a regular basis, at a rate consistent with their particular requirements. Verification of the proposed watering schedule shall be reviewed by the University's Representative prior to commencement of the maintenance.
 - 2. The maintenance of the plant materials shall comply with standard horticultural practice for the correct watering, fertilizing, pruning and spraying of the specimen boxed trees.

3. Irrigation: During construction the existing trees to be preserved shall, at the direction of the University's Representative, be given deep watering (be irrigated). Quantities and lengths of time are variable and shall depend upon seasonal rainfall.

E. Washing:

1. Contractor shall perform periodic washing of leaves to remove dust.

- F. Contractor shall keep plant material free from weeds and debris at all times.

3.8 CLEANUP

- A. Upon completion of the work, restore ground to required elevations and remove excess material debris and equipment from the site to the satisfaction of the University's Representative.

END OF SECTION

SECTION 01 57 00 - TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Protection of existing conditions, including video record of existing conditions.
- B. Life safety and fire protection.
- C. Security.
- D. Runoff control.
- E. Protection of installed Work.

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Contractor's use of site and premises.
- B. Section 01 52 00 - Construction Facilities: Field offices and sheds.
- C. Section 01 54 00 - Construction Aids: Temporary lifts and hoists; temporary stairs and scaffolding.
- D. Section 01 55 00 - Vehicular Access and Parking: Vehicle access and parking control at Work areas.
- E. Section 01 56 00 - Temporary Barriers and Enclosures: Requirements for dust and debris barriers.

1.4 CODES AND REGULATIONS

- A. Fire Regulations: Comply with requirements of fire authorities having jurisdiction, including California Fire Code (CFC) Article 87 during performance of the Work.
- B. Safety Regulations: Contractor shall be solely responsible for jobsite safety. Minimum requirements shall include the following.
 - 1. Comply with requirements of all applicable Federal, State and local safety rules and regulations, including but not limited to all OSHA regulations.
- C. Barricades and Barriers: As required by authorities having jurisdiction, provide substantial barriers, guardrails and enclosures around Work areas and adjacent to embankments and excavations for protection of workers and the public. See Section 01 56 00 - Temporary Barriers and Controls for additional requirements.

1.5 PROTECTION OF EXISTING CONDITIONS

- A. Protection of Adjacent Facilities: Contractor shall restrict Work to limits indicated on the Drawings and as specified in Section 01 11 00 - Summary of the Work. Protect existing, adjacent facilities from damage, including soiling and debris accumulation.
- B. Video Record of Existing Conditions: Contractor shall produce video record of all existing conditions within and adjacent to Project area.
 - 1. Record by video or digital photography in a format that is easily transferred to the University. Video shall have sound to record comments to identify locations and describe conditions.
 - 2. University's Representative will accompany Contractor during recording of existing conditions but will not direct recording process.
 - 3. Video shall record state of existing features, including but not limited to:
 - a. Paving.
 - b. Landscaping.
 - c. Building surfaces.
 - d. Utilities.
 - e. Lighting standards, fencing, signage and other site appurtenances.
 - 4. Contractor shall retain one copy and deliver one copy of video record to University's Representative within seven calendar days after the video record was produced.
 - 5. Video record shall be used to verify restoration of existing conditions after completion of construction activities.
 - 6. Existing feature not recorded shall be restored as directed by University's Representative, including reconstruction and refinishing as determined necessary by University's Representative.

1.6 FIRE PROTECTION

- A. Fire Protection Responsibility: Protection of Project from fire shall be solely Contractor's responsibility.
- B. Fire Protection Provisions, General: Maintain, at a minimum, the Work in conditions to minimize fire hazards and provide adequate fire protection devices, such as suitable fire extinguishers, blankets, warning signs and storage containers.
 - 1. Store combustible materials in containers in fire-safe locations.
 - 2. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
 - 3. Provide supervision of welding operations, combustion type temporary heating units, and similar sources of fire ignition.

- C. Special Fire Protection Provisions: During hazardous construction activities, maintain adequate fire

protection devices immediately available for use at the location of such activities.

- D. Fire Protection Equipment: Until fire protection is provided by permanent fire protection systems and equipment, install and maintain temporary fire protection equipment as necessary to protect against ignition and spread of fires. Comply with NFPA 10 "Standard for Portable Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alteration and Demolition Operations."
- E. Temporary Fire Sprinkler Provisions: Where existing fire sprinkler system is affected by demolition and re-construction activities, provide either temporary fire protection measures acceptable to authorities having jurisdiction or modify existing system as necessary to maintain fire protection. Include extensions and additions to standpipe system, for Fire Department connections. Comply with California Fire Code (CFC) Article 87 during all phases of the Work.
- F. Fire Extinguishers for Protection During Construction: Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.
 - 1. Provide hand carried, portable UL-rated, Class "A" fire extinguishers for temporary offices and similar spaces.
 - 2. In other locations, provide hand-carried, portable, UL-rated, Class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- G. Installation of Fire Extinguishers for Protection During Construction: Locate fire extinguishers in field offices, storage sheds, tool houses, other temporary buildings and throughout the Work site. Comply with directions of Fire Marshal having jurisdiction.
 - 1. In the area under construction, provide at least one fire extinguisher for each 5,000 square feet of building floor area.
 - 2. Locate fire extinguishers no greater than 75 feet travel distance apart.

1.7 SECURITY

- A. Security Responsibility: Security of the Project area shall be solely the Contractor's responsibility until completion of the Work. Reference Contract General Conditions Article 4.08-c, Protection of Facilities.
- B. Security Provisions, General: Provide security program and facilities to protect Work from unauthorized entry, vandalism, and theft. It is the contractor's responsibility to protect Work while Work is being conducted and during times of non-work. This includes all days, nights, weekends, and holidays from the issuance of the Notice to proceed to the final building occupancy by the University.
- C. Guard Service: At Contractor's discretion, employ guards to protect the site after working hours.

1.8 RUNOFF CONTROL

- A. Erosion and Sedimentation Control: Erosion and sedimentation control provisions shall meet or exceed minimum requirements of authorities having jurisdiction. When provisions are indicated on Drawings, they are minimum requirements. If no sedimentation control system is shown, then

Contractor shall design and provide system to prevent siltation of adjacent property as required by authorities having jurisdiction.

1. Implement erosion and sedimentation control provisions prior to commencing site clearing, grading, backfilling and compacting or other construction activities which will expose soil to erosion and potential for sediment-laden runoff.
 2. Ensure that sediment-laden water does not enter drainage systems.
 3. Maintain erosion and sedimentation control provisions until Contract Completion review is completed for landscaping, or sooner if approved by authorities having jurisdiction.
 4. Implementation, maintenance, replacement and additions to erosion and sedimentation control provisions shall solely be the responsibility of the Contractor. As construction progresses and seasonal conditions dictate, more erosion and sedimentation controls may be required. If so, Contractor shall provide additional provisions over and above minimum requirements as necessary.
- B. Drainage: Grade site and other Work areas to drain.
1. Provide temporary drainage ditches and diversion measures as necessary to protect construction.
 2. Provide erosion control measures as necessary and as required by authorities having jurisdiction. Comply with local water quality control requirements, as applicable.
- C. De-Watering: Maintain excavations free of water. Provide and operate pumping equipment as necessary.
1. Removal of contaminated water from excavations, dewatering of contaminated groundwater and discharging of contaminated soils via surface erosion is prohibited.
 2. Dewatering of non-contaminated groundwater shall be performed only after Contractor obtains a National Pollutant Discharge Elimination System Permit from the State or Regional Water Quality Control Board having authority. Costs of such permit shall be included in the Contract Sum.
- D. Runoff Control: Storm water runoff and other waters may be encountered at various times during construction. Contractor, by signing the Agreement, acknowledges that risks arising from storm water runoff and other waters have been investigated and considered, and Contract Sum and Contract Time include all costs associated with runoff control.
1. It shall be responsibility of Contractor to protect Work from detrimental effects of all waters encountered.
 2. It shall be responsibility of Contractor to protect Work from detrimental effects of runoff.
 3. Should damage to the Work due to surface or other water occur prior to acceptance of the Work by University's Representative, Contractor shall repair or replace Work at no change in Contract Time or Contract Sum.

- E. National Pollutant Discharge Elimination System: Contractor shall comply with requirements of environmental protection and storm drainage authorities having jurisdiction.
1. Project Area and other areas affected by Work under the Contract shall be maintained in such condition that anticipated storm runoff does not carry wastes and other pollutants off the site.
 2. Discharges of material other than storm water will be allowed only when necessary for performance of the Work and where such discharge does not cause the following:
 - a. Cause or contribute to a violation of applicable water quality standard.
 - b. Cause or threaten to cause pollution, contamination or nuisance, as determined by authorities having jurisdiction. Potential pollutants include but are not limited to:
 - 1) Solid or liquid chemical spills.
 - 2) Wastes from paints, stains, sealants, adhesives, limes, pesticides, herbicides, wood preservatives and solvents.
 - 3) Asbestos fibers, paint flakes or fragments of plaster and drywall.
 - 4) Fuels, lubricants, hydraulic fluids, coolants, battery electrolytes.
 - 5) Vehicle or equipment, degreasing, steam cleaning and wash water.
 - 6) Concrete, mortar and plaster mix and cleaning water.
 - 7) Detergents and floatable wastes.
 - 8) Superchlorinated potable water line flushings.
 - c. Contain hazardous substances in a quantity reportable under Federal Regulations 40 CFR Parts 117 and 302.
 3. During performance of the Work, disposal of such materials shall occur at a temporary on-site location, physically separated from potential storm water runoff, with ultimate disposal in compliance with all applicable local, regional, State and Federal requirements.
 4. Contractor shall obtain and comply with Storm Water Pollution Prevention Plan (SWPPP). Contractor shall be responsible for payment of the permit and all fines for non-compliance with the SWPPP, at no change in Contract Sum.
- F. Pavement clearing and cleaning: Keep site access ways, parking areas and building access and exit facilities clear of mud.
1. Remove mud, soil and debris and dispose in a manner which will not be injurious to persons, property, plant materials and site.
 2. Comply with runoff control requirements stated above and as required by authorities having jurisdiction.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 58 00 - PROJECT IDENTIFICATION SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. On-site Project identification and temporary informational signs provided by University and maintained by Contractor during Contract.

1.3 RELATED SECTIONS

- A. Section 01 52 00 – Construction Facilities: Coordination of signage with field offices and sheds.
- B. Section 01 54 01 – Security: Personnel identification badges.
- C. Section 01 55 00 – Vehicular Access and Parking: Coordination of signage with construction parking
- D. Section 01 56 00 – Temporary Barriers and Enclosures: Temporary wood barriers and enclosures with directional signage.

1.4 SUBMITTALS

- A. Shop Drawings: In compliance with directions from University's Representative, Contractor shall prepare and submit site plan locating temporary project identification and informational signs furnished by University.

PART 2 - PRODUCTS

2.1 SIGN MATERIALS

- A. Sign Structure and Framing: Contractor shall provide new materials, wood or metal, structurally adequate to support sign panel and suitable for specified finish.
- B. Sign Surfaces: Sign shall be designed and provided by the University. Sign shall be installed by the contractor.
 - 1. For Contractor information: Sign surfaces shall be minimum 3/4-inch thick, exterior grade, softwood plywood with medium or high-density phenolic sheet overlay, standard large sizes to eliminate joints.
 - 2. Contractor shall provide backing or additional support as required to span across framing members and provide even, smooth surface without waves or buckles.

- C. Rough Hardware: Rough hardware shall be hot-dip galvanized steel.
- D. Paint, Sign Structure: Paint used for Sign Structure shall be exterior quality, primer and flat finish paint, adequate to resist weathering and fading for scheduled construction period.

2.2 PROJECT IDENTIFICATION SIGN

- A. Project Identification Sign: As directed, Contractor shall install one University furnished painted Project Identification Sign of the size and construction indicated on graphic to be provided by Architect.
 - 1. Graphic design, text, style of lettering, and colors of sign shall be as directed by University Marketing Department.
 - 2. Sign shall identify project name, project number, University's name, with University Project Manager's Name and contact information, Architect's name and Contractor's name.
 - 3. Sign shall include corporate logos of parties identified on sign.
- C. Project Address Signs: Contractor shall provide Project name and street address signs, minimum of four feet wide, to identify Project to facilitate deliveries.
 - 1. Graphic design and colors of sign shall match Project Identification Sign.
 - 2. Text on sign shall be as directed.
- D. Sign Painting: Sign Panels shall be shop painted and field installed by Contractor.

2.3 PROJECT INFORMATIONAL SIGNS

- A. Restrictions: Contractor shall not display signs other than Project Identification Sign specified above and Project Informational Signs specified below without written approval of University's Representative.
- B. Project Informational Signs: Informational signs, necessary for conduct of construction activities or required by governmental authorities having jurisdiction, may be displayed when in conformance to sign construction and graphic requirements specified in this Section.
 - 1. University's Representative may review such signs. If so, review will be for sign construction, and graphic designs only.
 - 2. Adequacy of signage for safety and conformance to requirements of authorities having jurisdiction and trade practices shall be solely Contractor's responsibility.
- C. Sign Painting: Contractor shall ensure that informational signage shall be produced by professional sign painters and be of size and lettering style consistent with use. Colors shall be as required by authorities having jurisdiction and, if not otherwise required, of colors consistent with Project graphics.
 - 1. Sign Face Finish: Sign face finish shall be gloss enamel.
 - 2. Structure Finish: Sign structure finish shall be paint exposed surfaces of supports and framing members one coat of primer and one coat of exterior paint, flat finish.

PART 3 – EXECUTION

3.1 PROJECT IDENTIFICATION SIGN INSTALLATION

- A. Project Identification Sign Construction: Contractor shall construct sign support structure and install panels in durable manner, to resist high winds.
- B. Project Identification Sign Installation: Contractor shall erect Project Identification Sign on site at a lighted location of high public visibility, adjacent to the main entrance to the site, as approved by University's Representative.
 - 1. Contractor shall install sign at height for optimum visibility, on ground-mounted poles or attached to portable structure on skids.
 - 2. Portable structure shall resist overturning force of wind.
- C. Street Address Signs: Contractor shall locate and install signs at each access point from public streets.
- D. Field Painting: Contractor shall paint all surfaces and edges of sign face and support structure for finished appearance.

3.2 PROJECT INFORMATIONAL SIGN INSTALLATION

- A. Project Informational Signs Construction: Contractor shall construct sign support structure and install panels in durable manner, to resist high winds.
- B. Project Informational Sign Installation:
 - 1. Contractor shall locate signs as necessary for construction activities and as required by authorities having jurisdiction.
 - 2. Contractor shall install informational signs for optimum visibility, on ground-mounted posts or temporarily attached to surfaces of structures.
 - 3. Attachment methods shall leave no permanent disfiguration or discoloration on completed work.
- C. Field Painting: Contractor shall paint all surfaces and edges of sign face and support structure for finished appearance.

3.3 SIGNS MAINTENANCE

- A. Signs Maintenance: Contractor shall maintain signs and supports in a neat, clean condition. Contractor shall repair all damage and weathering to structure, framing and signage.
- B. Sign Relocation: Contractor shall relocate signs as required by progress of the work.

3.4 REMOVAL

- A. Project Identification Sign Removal: Contractor shall remove Project Identification Sign when directed. Contractor shall coordinate removal with requirements specified in Section 01 51 00 – Temporary Utilities, Section 01 52 00 – Construction Facilities, Section 01 55 00 – Vehicular Assess and

Parking and Section 01 56 00 – Temporary Barriers and Enclosures.

- B. Project Informational Signs Removal: Contractor shall remove all informational signs, framing, supports and foundations prior to Contract Completion review. Contractor shall coordinate removal with requirements specified in Section 01 51 00 – Temporary Utilities, Section 01 52 00 – Construction Facilities, Section 01 55 00 – Vehicular Access and Parking and Section 01 56 00 – Temporary Barriers and Enclosures.

END OF SECTION

EDA PROJECT SIGN

The Contractor shall supply, erect, and maintain in good condition a project sign according to the specifications set forth below:

EDA SITE SIGN SPECIFICATIONS

Size: 4' x 8' x ¾"

Materials: Exterior grade/MDO plywood (APA rating A-B)

Supports: 4" x 4" x 12' posts with 2" x 4" cross branching

Erection: Posts shall be set a minimum of three feet deep in concrete footings that are at least 12" in diameter.

Paint: Outdoor enamel

Colors: Jet Black, Blue (PMS300), and Gold (PMS7406). Specifically, on white background the following will be placed:

The U. S. Department of Commerce seal in blue, black, and gold;

“EDA” in blue;

“U. S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT
ADMINISTRATION” in black;

“In partnership with” in blue;

(Actual name of the) “EDA Grant Recipient” in black;

“Donald J. Trump, President of the United States” in black.

Lettering: Specific fonts are named below; positioning will be as shown on the attached illustration.

“U. S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT
ADMINISTRATION” use Bank Gothic Medium - **BANK GOTHIC MED**

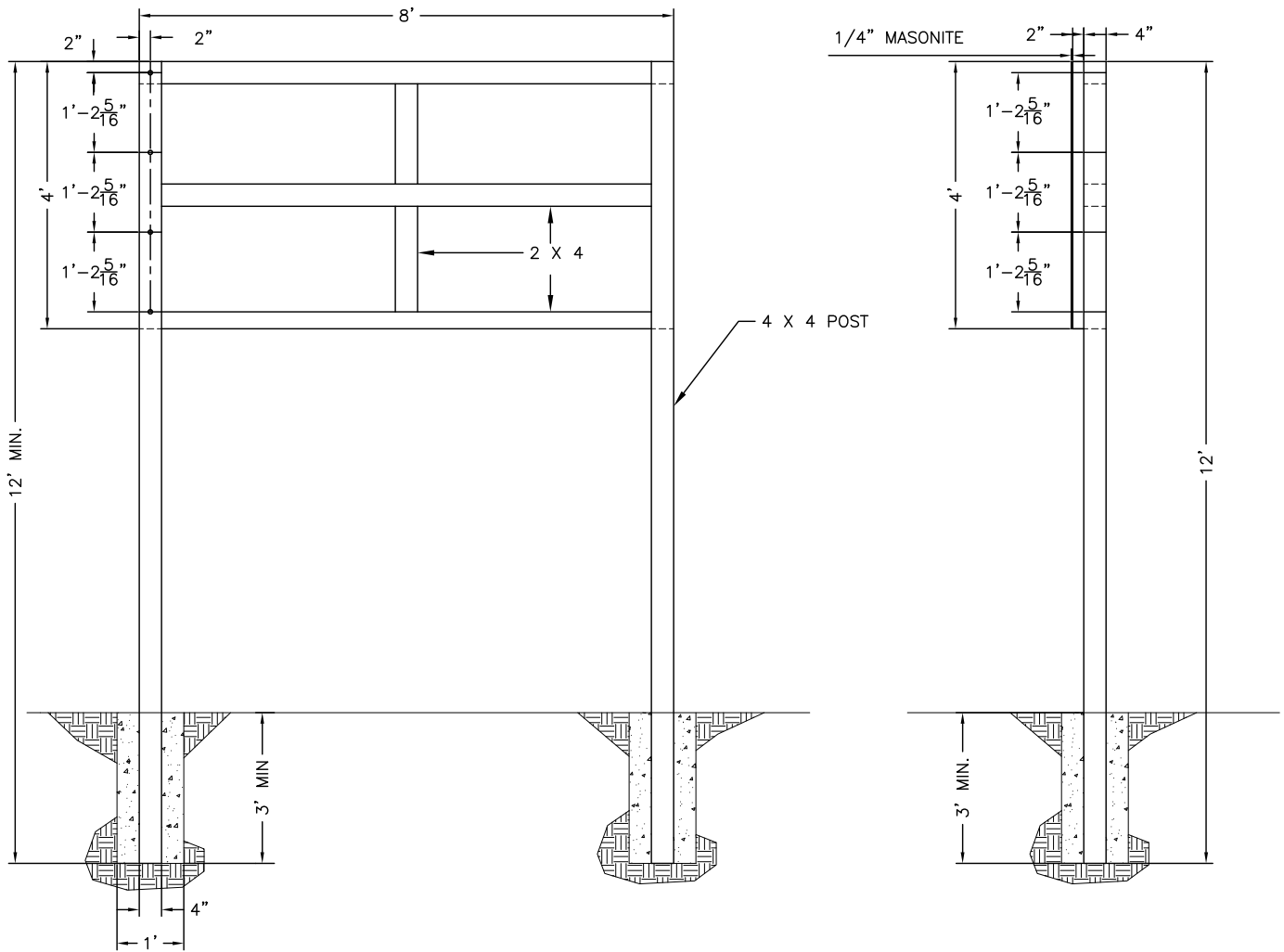
“In partnership with” use Univers™ 55 Oblique - **Univers 55**

(Name of) “EDA Grant Recipient” use Univers™ Extra Black 85 **Univers 85**

“Donald J. Trump, President of the United States” use Univers™ 55 Oblique - **Univers 55**

Project signs will not be erected on public highway rights-of-way. If any possibility exists for obstruction to traffic line of sight, the location and height of the sign will be coordinated with the agency responsible for highway or street safety in the area.

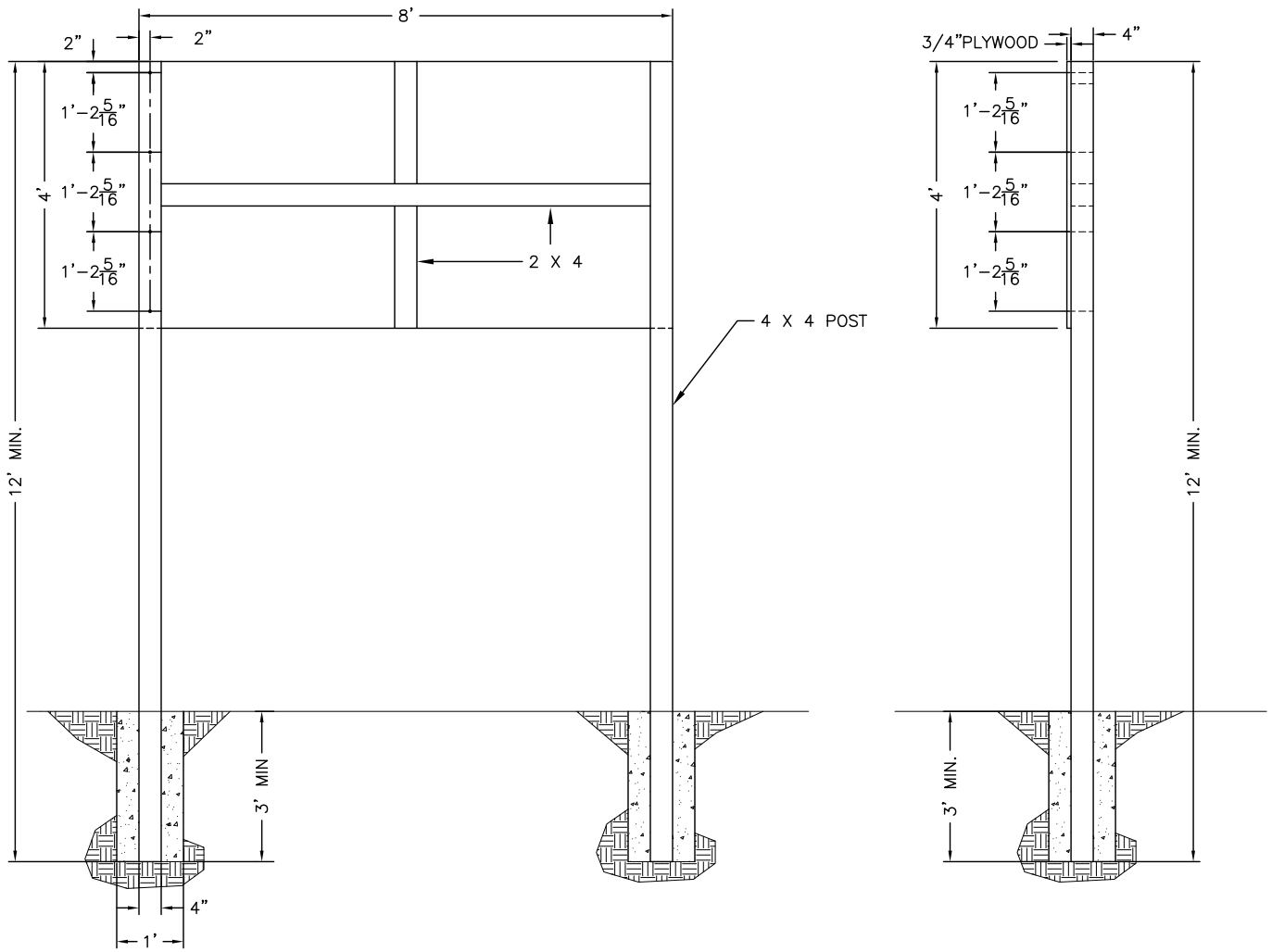
The EDA Regional Director may permit modifications to these specifications if they conflict with state law or local ordinances.



SIGN A
MASONITE SIGN
SCALE: 3/8" = 1'

PROJECT - SIGN A

ECONOMIC DEVELOPMENT ADMINISTRATION



SIGN B
PLYWOOD SIGN
SCALE: 3/8" = 1'

PROJECT - SIGN B

ECONOMIC DEVELOPMENT ADMINISTRATION



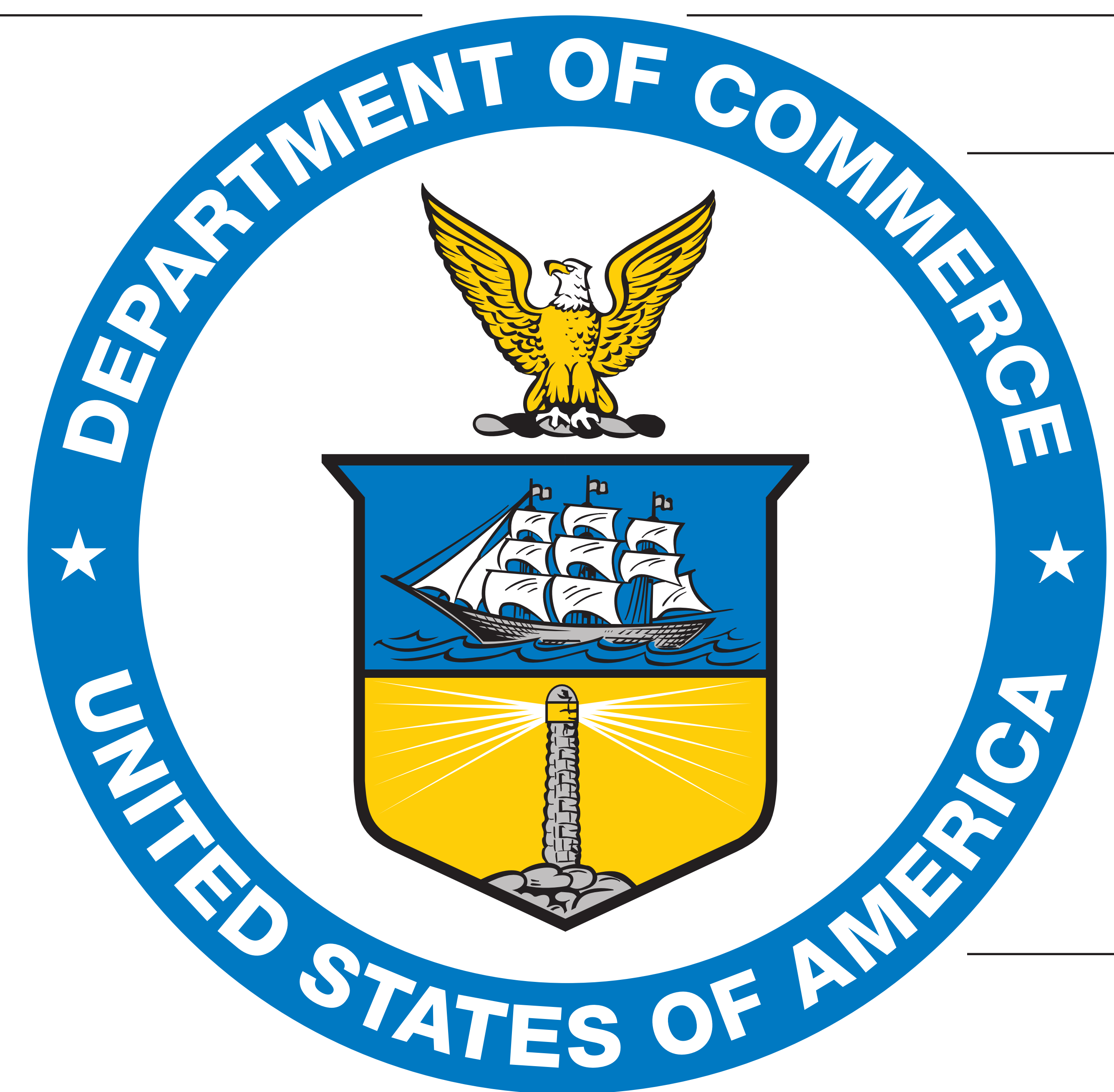
EDA

U.S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT ADMINISTRATION

In partnership with

<EDA Grant Recipient Name>

Donald J. Trump, President of the United States



EDA

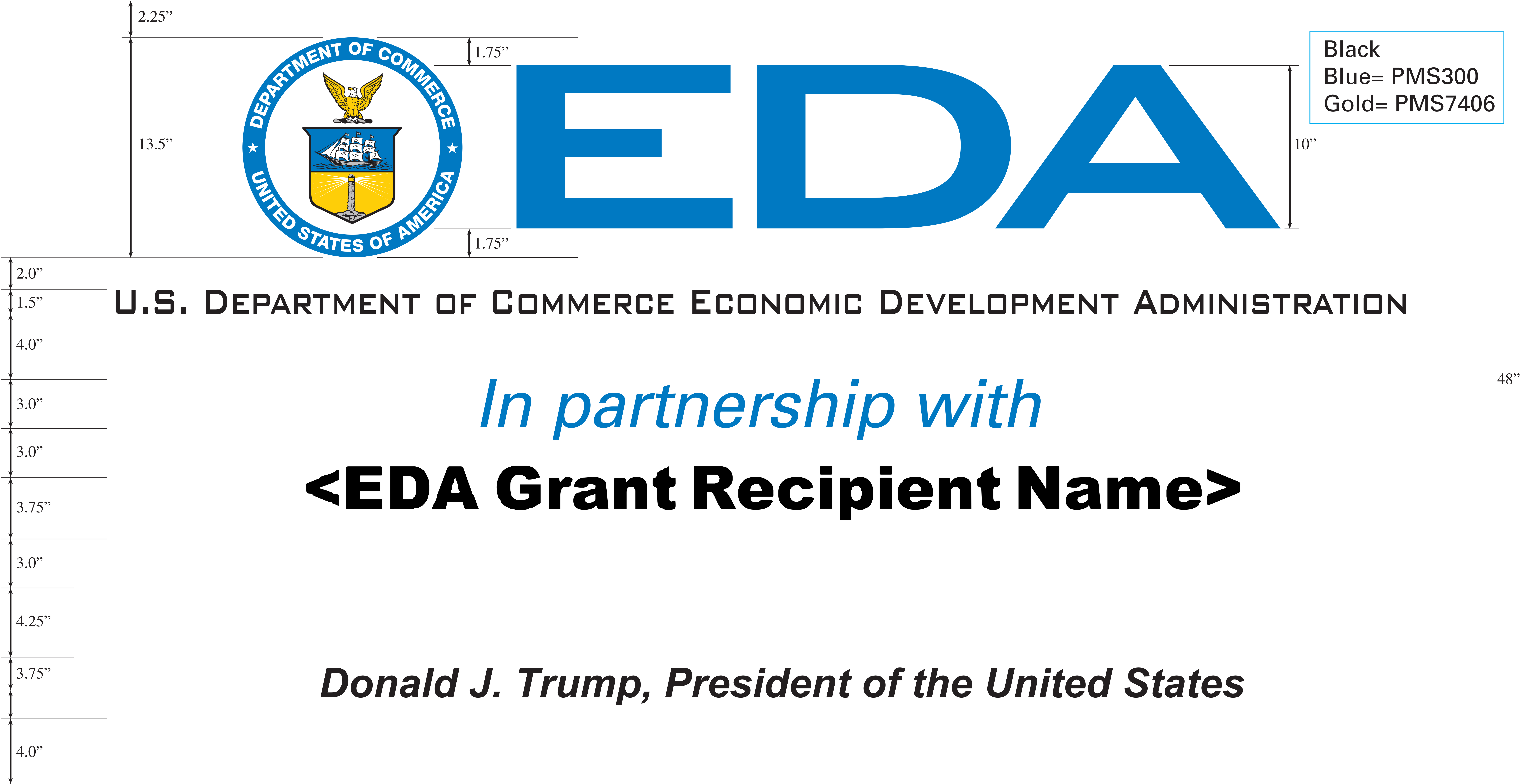
Black
Blue= PMS300
Gold= PMS7406

U.S. DEPARTMENT OF COMMERCE ECONOMIC DEVELOPMENT ADMINISTRATION

In partnership with

<EDA Grant Recipient Name>

Donald J. Trump, President of the United States



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SECTION 01 61 00 - BASIC PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. General requirements for products used for the Work, including:
 - 1. General characteristics of products
 - 2. Product options
 - 3. System completeness
 - 4. Transportation and handling requirements
 - 5. Storage and protection of products
 - 6. Installation of products.

1.3 RELATED SECTIONS

- A. Section 01 33 00 - Submittals Procedures: Requirements applicable to submittals for "or equal" and substitute products.
- B. Section 01 41 00 - Regulatory Requirements: Codes and standards applicable to product specifications; minimum requirements.
- C. Section 01 42 00 - Reference Standards and Abbreviations: References to various standards, standard specifications, codes, practices and other requirements.
- D. Section 01 64 00 - Owner-Furnished Products: Requirements for installing products furnished by University.
- E. Section 01 65 00 - Product Delivery Requirements: General requirements for delivery of products to Project site.
- F. Section 01 66 00 - Product Storage and Handling Requirements: General requirements for storage and handling of products.

1.4 GENERAL PRODUCT REQUIREMENTS

- A. Products, General: "Products" include items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock, and include materials, equipment, assemblies, fabrications and systems.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model designations indicated in the manufacturer's published product data.

2. **Materials:** Products that are shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed or installed to form a part of the Work.
 3. **Equipment:** A product with operating parts that are motorized or manually operated and require connections such as wiring or piping.
- B. **Specific Product Requirements:** Refer to requirements of Section 01 45 00 - Quality Control and individual product Specifications Sections in Divisions 2 through 49 for specific requirements for products.
- C. **Minimum Requirements:** Specified requirements for products are minimum requirements. Refer to general requirements for quality of the Work specified in Section 01 45 00 - Quality Control and elsewhere herein.
- D. **Product Selection:** Provide products that fully comply with the Contract Documents, are undamaged and unused at installation. Comply with additional requirements specified herein in Article titled "PRODUCT OPTIONS".
- E. **Standard Products:** Where specific products are not specified, provide standard products of types and kinds that are suitable for the intended purposes and that are usually and customarily used on similar projects under similar conditions. Products shall be as selected by Contractor and subject to review and acceptance by the Architect.
- F. **Product Completeness:** Provide products complete with all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect. Comply with additional requirements specified herein in Article titled "SYSTEM COMPLETENESS".
- G. **Code Compliance:** All products, other than commodity products prescribed by Code, shall have a current ICBO Evaluation Service (ICBO ES) Research Report or National Evaluation, Inc. Report (NER). Refer to additional requirements specified in Section 01 41 00 - Regulatory Requirements.
- H. **Interchangeability:** To the fullest extent possible, provide products of the same kind from a single source. Products required to be supplied in quantity shall be the same product and interchangeable throughout the Work. When options are specified for the selection of any of two or more products, the product selected shall be compatible with products previously selected.
- I. **Product Nameplates and Instructions:**
1. Except for required Code-compliance labels and operating and safety instructions, locate nameplates on inconspicuous, accessible surfaces. Do not attach manufacturer's identifying nameplates or trademarks on surfaces exposed to view in occupied spaces or to the exterior.
 2. Provide a permanent nameplate on each item of service-connected or power-operated equipment. Nameplates shall contain identifying information and essential operating data such as the following example:
 - Designation of product as identified on the Plans and Specifications
 - Name of manufacturer
 - Name of product
 - Model and serial number
 - Capacity

Operating and Power Characteristics
Labels of Tested Compliance with Codes and Standards

3. For each item of service-connected or power-operated equipment, provide operating and safety instructions, permanently affixed and of durable construction, with legible machine lettering. Comply with all applicable requirements of authorities having jurisdiction and listing agencies.
 4. Permanent nameplate shall be constructed from metal with lettering punched or indented into the material. "Permanent" marker or other inks shall not be used.
- J. Plumbing Product Requirements: Comply with requirements specified in Division 22 - Plumbing
- K. Mechanical Product Requirements: Comply with requirements specified in Division 23 - Mechanical.
- L. Electrical Product Requirements: Comply with requirements specified in Division 26 - Electrical.

1.5 PRODUCT OPTIONS

- A. Product Options: Refer to Contract General Conditions, Article 5.04. Provisions of Public Contract Code Section 03400 shall apply, as supplemented by the following general requirements.
- B. Products Specified by Description: Where Specifications describe a product, listing characteristics required, with or without use of a brand name, provide a product that has the specified attributes and otherwise complies with specified requirements.
- C. Products Specified by Performance Requirements: Where Specifications require compliance with performance requirements, provide product(s) that comply and are recommended by the manufacturer for the intended application. Verification of manufacturer's recommendations may be by product literature or by certification of performance from manufacturer.
- D. Products Specified by Reference to Standards: Where Specifications require compliance with a standard, provided product shall fully comply with the standard specified. Refer to general requirements specified in Section 01 42 00 - Reference Standards and Abbreviations regarding compliance with referenced standards, standard specifications, codes, practices and requirements for products.
- E. Products Specified by Identification of Manufacturer and Product Name or Number:
1. Sole, source, no other product shall be accepted: Provide the specified product(s) of the specified manufacturer. No substitutions shall be allowed.
 2. "Acceptable Manufacturers": Product(s) of the named manufacturers, if equivalent to the specified product(s) of the specified manufacturer, will be acceptable in accordance with the requirements specified herein in the Article titled "'OR EQUAL' PRODUCTS."
 3. Unnamed manufacturers: Products of unnamed manufacturers will be acceptable only as follows:
 - a. Unless specifically stated that equals will not be accepted or considered, the phrase "or equal" shall be assumed to be included in the description of specified product(s). Equivalent products of unnamed manufacturers will be accepted in accordance with the "or equal"

provision specified herein, below.

- b. If provided, products of unnamed manufacturers shall be subject to the requirements specified herein in the Article titled "'OR EQUAL' PRODUCTS."
4. Quality basis: Specified product(s) of the specified manufacturer shall serve as the basis by which products by named acceptable manufacturers and products of unnamed manufacturers will be evaluated. Where characteristics of the specified product are described, where performance characteristics are identified or where reference is made to industry standards, such characteristics are specified to facilitate evaluation of products by identifying the most significant attributes of the specified product(s).
- F. Products Specified by Combination of Methods: Where products are specified by a combination of attributes, including manufacturer's name, product brand name, product catalog or identification number, industry reference standard, or description of product characteristics, provide products conforming to all specified attributes.
- G. "Or Equal" Provision: Where the phrase "or equal" or the phrase "or approved equal" is included, product(s) of unnamed manufacturer(s) may be provided as specified above in subparagraph titled "Unnamed manufacturers."
1. The requirements specified herein in the Article titled "'OR EQUAL' PRODUCTS" shall apply to products provided under the "or equal" provision.
 2. Use of product(s) under the "or equal" provision shall not result in any delay in completion of the Work, including completion of portions of the Work for use by University or for work under separate contract by University.
 3. Use of product(s) under the "or equal" provision shall not result in any costs to University, including design fees and permit and plan check fees.
 4. Use of product(s) under the "or equal" provision shall not require substantial change in the intent of the design, in the opinion of the Architect. The intent of the design shall include functional performance and aesthetic qualities.
 5. The determination of equivalence will be made by the Architect, and such determination shall be final.
- H. Visual Matching: Where Specifications require matching a sample, the decision by the Architect on whether a proposed product matches shall be final. Where no product visually matches, but the product complies with other requirements, comply with provisions for substitutions for selection of a matching product in another category.
- I. Selection of Products: Where requirements include the phrase "as selected from manufacturer's standard colors, patterns and textures", or a similar phrase, selections of products will be made by indicated party or, if not indicated, by the Architect. The Architect will select color, pattern and texture from the product line of submitted manufacturer, if all other specified provisions are met.

1.6 "OR EQUAL" PRODUCTS

- A. "Or Equal" Products: Products are specified typically by indicating a specified manufacturer and

specific products of that manufacturer, with acceptable manufacturers identified with reference to this "or equal" provision. If Contractor proposes to provide products other than the specified products of the specified manufacturer, provisions of any relevant Supplementary General Conditions, Contract General Conditions Article 5.04, and Public Contract Code section 3400 shall apply. Contractor shall submit if and when directed by Architect, complete product data, including drawings and descriptions of products, fabrication details and installation procedures. Include samples where applicable or requested.

1. Submit a minimum of four copies. Form and other administrative requirements shall be as directed by the Architect.
 2. Include appropriate product data for the specified product(s) of the specified manufacturer, suitable for use in comparison of characteristics of products.
 - a. Include a written, point-by-point comparison of characteristics of the proposed equal product with those of the specified product.
 - b. If the proposed equal is accepted, Contractor shall include a detailed description in written or graphic form as appropriate, indicating all necessary changes or modifications to other elements of the Work and to construction to be performed by the University and others under separate contract with University.
 3. "Or Equal" product submissions shall include a statement indicating the equal's effect on the Construction Schedule. Contractor shall indicate the effect of the proposed products on overall Contract Time and, as applicable, on completion of portions of the Work for use by University or for work under separate contract by University.
 4. "Or Equal" product submissions shall include signed certification that the Contractor has reviewed the proposed products and has determined that the products are equivalent or superior in every respect to product requirements indicated or specified in the Contract Documents, and that the proposed products are suited for and can perform the purpose or application of the specified product indicated or specified in the Contract Documents.
 5. "Or Equal" product submissions shall include a signed waiver by the Contractor for change in the Contract Time or Contract Sum because of the following:
 - a. "Or equal" product failed to perform adequately.
 - b. "Or equal" product required changes in on other elements of the Work.
 - c. "Or equal" product caused problems in interfacing with other elements of the Work.
 6. If, in the opinion of the Architect, the "or equal" product request is incomplete or has insufficient data to enable a full and thorough review of the proposed products, the proposed products may be summarily refused and determined to be unacceptable.
- B. Product Substitutions: For products not governed by the "or equal" provision, comply with substitution provisions of the Contract General Conditions (Article 5.04-d, Substitutions) and requirements specified in Section 01630 - Product Substitution Procedures.

1.7 SYSTEM COMPLETENESS

- A. System Completeness
1. The Contract Drawings and Specifications are not intended to be comprehensive directions on

how to produce the Work. Rather, the Drawings and Specifications are instruments of service prepared to describe the design intent for the completed Work.

2. It is intended that all equipment, systems and assemblies be complete and fully functional even though not fully described. Provide all products and operations necessary to achieve the design intent described in the Contract Documents.
3. Refer to related general requirements specified in Section 01 41 00 - Regulatory Requirements regarding compliance with minimum requirements of applicable codes, ordinances and standards.

B. Omissions and Misdescriptions: Contractor shall report to Architect immediately when elements essential to proper execution of the Work are discovered to be missing or misdescribed in the Drawings and Specifications or if the design intent is unclear.

1. Should an essential element be discovered as missing or misdescribed prior to receipt of Bids, an Addendum will be issued so that all costs may be accounted for in the Contract Sum.
2. Should an obvious omission or misdescription of a necessary element be discovered and reported after execution of the Agreement, Contractor shall provide the element as though fully and correctly described, and a no-cost Change Order shall be executed.
3. Refer to related general requirements specified in Section 01 31 00 - Coordination regarding construction interfacing and coordination.

1.8 TRANSPORTATION, DELIVERY AND HANDLING

A. Transportation, Delivery and Handling, General: Contractor shall comply with manufacturer's instructions and recommendations for transportation, delivery and handling, in addition to the following.

B. Transportation: Contractor shall transport products by methods to avoid product damage.

C. Delivery:

1. Contractor shall schedule delivery to minimize long-term storage and prevent overcrowding construction spaces. Contractor shall coordinate with installation to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other losses.
2. Contractor shall deliver products in undamaged condition in manufacturer's original sealed container or packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.
3. The Contractor shall not have products of any type that are intended to be received by the Contractor delivered to the University's Mail and Package receiving Warehouse.

D. Handling:

1. Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, marring or other damage.
2. Contractor shall promptly inspect products on delivery to ensure that products comply with Contract Documents, quantities are correct, and to ensure that products are undamaged and properly protected.

1.9 STORAGE AND PROTECTION

A. Storage and Protection, General: Contractor shall store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible.

1. Contractor shall periodically inspect to ensure products are undamaged, and are maintained under required conditions.
 2. Contractor shall remove and replace products damaged by improper storage or protection with new products at no change in Contract Sum or Contract Time.
 3. Contractor shall store sensitive products in weather tight enclosures or by other means recommended by the manufacturer.
- B. Inspection Provisions: Contractor shall arrange storage to provide access for inspection and measurement of quantity or counting of units.
- C. Structural Considerations: Contractor shall store heavy materials away from the structure in a manner that will not endanger supporting construction.
- D. Weather-Resistant Storage:
1. Contractor shall store moisture-sensitive products above ground, under cover in a weather tight enclosure or covered with an impervious sheet covering. Contractor shall provide adequate ventilation to avoid condensation.
 2. Contractor shall maintain storage within temperature and humidity ranges required by manufacturer's instructions.
 3. For exterior storage of fabricated products, Contractor shall place products on raised blocks, pallets or other supports, above ground and in a manner to not create ponding or misdirection of runoff. Contractor shall place on sloped supports above ground.
 4. Contractor shall store loose granular materials on solid surfaces in a well-drained area. Contractor shall prevent mixing with foreign matter.
- E. Protection of Completed Work:
1. Contractor shall provide barriers, substantial coverings and notices to protect installed Work from traffic and subsequent construction operations.
 2. Contractor shall remove protective measures when no longer required and prior to Contract Completion review of the Work.
 3. Contractor shall comply with additional requirements specified in Section 01560 - Temporary Barriers and Enclosures.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. Installation of Products:
1. Contractor shall comply with manufacturer's instructions and recommendations for installation of products, except where more stringent requirements are specified and necessary due to Project conditions or are required by authorities having jurisdiction.

2. Contractor shall anchor each product securely in place, accurately located and aligned with other Work.
3. Contractor shall clean exposed surfaces and provide protection to ensure freedom from damage and deterioration at time of Contract Completion review. Contractor shall refer to additional requirements specified in Section 01 74 00 - Cleaning Requirements and Section 01 56 00 - Temporary Barriers and Enclosures.

END OF SECTION

SECTION 01 63 00 - PRODUCT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. General requirements applicable to substitutions of materials, products, equipment and systems.

1.3 SUBSTITUTION OF MATERIALS AND EQUIPMENT

- A. Substitutions, General: Catalog numbers and specific brands or trade names are used in materials, products, equipment and systems required by the Specifications to establish the standards of quality, utility and appearance required. Alternative products which are of equal quality and of required characteristics for the purpose intended may be proposed for use provided the Contractor complies with provisions of Contract General Conditions, Article 5.04., subject to the following provisions.

1. See Section 01 61 00 - Basic Product Requirements for requirements regarding product options.
2. Substitutions during the course of Work will only be authorized by properly executed Change Order or Field Instruction. Substitutions during the bidding and/or negotiation phases shall be added to the identified specification by Addendum.
3. **Note: the Trustees have no obligation to entertain substitutions.**

- B. Substitution Provisions:

1. Documentation: Substitutions will not be considered if they are indicated or implied on shop drawing, product data or sample submittals. All requests for substitution shall be by separate written request from Contractor. See paragraph below for documentation required in the submission of request for substitution.
2. Cost and Time Considerations: Substitutions will not be considered unless a net reduction in Contract Sum or Contract Time results to University's benefit, including redesign costs, life cycle costs, plan check and permit fees, changes in related Work and overall performance of building systems.
3. Design Revision: Substitutions will not be considered if acceptance will require substantial revision of the Contract Documents or will substantially change the intent of the design, in the opinion of the Architect. The intent of the design shall include functional performance and aesthetic qualities.
4. Data: It shall be the responsibility of the Contractor to provide adequate data demonstrating

- the merits of the proposed substitution, including cost data and information regarding changes in related Work.
5. **Determination by Architect:** Architect and University's Representative will determine the acceptability of proposed substitutions, and University's Representative will notify Contractor in writing of acceptance or rejection. The determination by the Architect regarding functional performance and aesthetic quality shall be final.
 6. **Non-Acceptance:** If a proposed substitution is not accepted, Contractor shall immediately provide the specified product.
 7. **Substitution Limitation:** Only one request for substitution will be considered for each product.
- C. **Request for Substitution Procedures:** Comply with provisions of Contract General Conditions, Article 5.04 and the following.
1. Contractor shall prepare a request for substitution and submit the request to Architect through University's Representative for review and recommendation for acceptance. Acceptance and approval of substitutions shall be by University's Representative.
 - a. Submit a minimum of five hard copies or submit electronically to the University's Representative.
 - b. Present the request for substitution using form provided below.
 - c. Comply with other administrative requirements shall be as directed by University's Representative.
 2. Substitution requests shall include complete product data, including drawings and descriptions of products, fabrication details and installation procedures. Include samples where applicable or requested.
 3. Substitution requests shall include appropriate product data for the specified product(s) of the specified manufacturer, suitable for use in comparison of characteristics of products.
 - a. Include a written, point-by-point comparison of characteristics of the proposed substitute product with those of the specified product.
 - b. Include a detailed description, in written or graphic form as appropriate, indicating all changes or modifications needed to other elements of the Work and to construction to be performed by the University and by others under separate contracts with University that will be necessary if the proposed substitution is accepted.
 4. Substitution requests shall include a statement indicating the substitution's effect on the Construction Schedule. Indicate the effect of the proposed substitution on overall Contract Time and, as applicable, on completion of portions of the Work for use by University or for work under separate contracts by University.
 5. Except as otherwise specified, substitution requests shall include detailed cost data, including a proposal for the net change, if any, in the Contract Sum.
 6. Substitution requests shall include signed certification that the Contractor has reviewed the proposed substitution and has determined that the substitution, in combination with the cost or time savings, represents an equivalent or superior condition in every respect to product

requirements and value indicated or specified in the Contract Documents, and that the substitution is suited for and can perform the purpose or application of the specified product indicated or specified in the Contract Documents.

7. Substitution requests shall include a signed waiver by the Contractor for change in the Contract Time or Contract Sum because of the following:
 - a. Substitution failed to perform adequately.
 - b. Substitution required changes in on other elements of the Work.
 - c. Substitution caused problems in interfacing with other elements of the Work.
 - d. Substitution was determined to be unacceptable by authorities having jurisdiction.
8. If, in the opinion of the Architect, the substitution request is incomplete or has insufficient data to enable a full and thorough review of the intended substitution, the substitution may be summarily refused and determined to be unacceptable.

D. Contract Document Revisions:

1. Should a Contractor-proposed substitution or alternative sequence or method of construction require revision of the Contract Drawings or Specifications, including revisions for the purposes of determining feasibility, scope or cost, or revisions for the purpose of obtaining review and approval by authorities having jurisdiction, Architect or other consultant of University who is the responsible design professional will make revisions as approved in writing in advance by University's Representative.
2. Contractor shall pay for services of Architect, other responsible design professionals and University for researching and reporting on proposed substitutions or alternative sequence and method of construction when such activities are considered additional services to the design services contracts of Architect or other responsible design professional with University.
3. Contractor shall pay for costs of services by Architect, other responsible design professionals and University. These costs may include travel, reproduction, long distance telephone and shipping costs reimbursable at cost plus usual and customary mark-up for handling and billing.
4. Contractor shall pay such fees whether or not the proposed substitution or alternative sequence or method of construction is ultimately accepted by University and a Change Order is executed.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

SUBSTITUTION REQUEST FORM

SUBSTITUTION REQUEST NUMBER: _____

TO: _____

PROJECT: _____

SPECIFIED ITEM: _____

Section	Page	Paragraph	Description
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The undersigned requests consideration of the following:

Proposed Substitution (Manufacturer, Model # or Name, Color, Etc.): _____

History: ___ New Product, ___ Available 2-5 Years, ___ Available 6-10 Years, ___ Available 10+ Years

Provide UL, ITS, WHI, (or other) listing / rating of proposed substitution: _____

Attached data shall include, but not be limited to, product, specification, drawings, performance and test data adequate for evaluation of the request for the proposed substitution product and the specified product, with applicable portions of the proposed substitution and the specified product data clearly identified in a point-by-point direct comparison chart. Incomplete form and attachments will result in rejection of substitution request.

Requestor shall address the following items on this Substitution Request Form. Use a separate attached sheet attached as needed:

1. Reason for not providing specified item:

2. Will proposed substitution affect dimensions indicated on Drawings? ___(Yes) ___(No)

If yes, how? _____

3. Will proposed substitution affect Electrical, Mechanical, Structural, Architectural, etc.? ___(Yes) ___(No) If yes, explain:

4. Is proposed substitution larger or smaller than specified product? ___(Yes) ___(No)

If yes, state size of substitute product: _____

5. Does proposed substitution weight less/more than specified product? ____ (Yes) ____ (No)
If yes, state weight of substitute product:

6. Will proposed substitution affect other trades and/or parts of the work? ____ (Yes) ____ (No)
If yes, explain all effects:

7. Comparison between proposed substitution and specified product (Similarities / Differences)?

8. If Substitution Request is accepted, Owner will receive a credit of \$ _____. The Contract Sum will be adjusted accordingly.

9. Will proposed substitution affect the Contract Time? ____ (Yes) ____ (No)

If yes, ____ (Add) ____ (Deduct) _____ calendar days.

INITIAL

UNDERSIGNED CERTIFIES:

_____ Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.

_____ Proposed substitution has same or better warranty as specified product.

_____ Proposed substitution has same or better maintenance service and availability of replacement parts as specified product.

_____ Proposed substitution will not affect or delay the Construction Schedule.

_____ Claims for additional costs related to accepted substitution, which may subsequently become apparent, are hereby waived.

_____ Proposed substitution will not affect dimensions and functional clearances.

_____ Coordination, installation, and changes in the Work as necessary for installation of accepted substitution will be complete in all respects, at no additional cost to Owner.

_____ Contractor will pay for all costs associated with changes to the project's design, including, but not limited to, architectural or engineering design fees, detailing, Agency approvals and construction costs caused by the requested substitution.

_____ The function, appearance and quality of the proposed substitution is equivalent or superior to the specified item.

The undersigned certifies that the above is accurate and correct.

Signature: _____

Company: _____

Address: _____

Date: _____

Telephone: _____

Attachments: _____ Product Data ___ Samples ___ Tests ___ Reports ___ Other (Describe)

Architect's Review and Action:

_____ Substitution Accepted – Make submittals in accordance with Specification Division 01 33 00.

_____ Substitution Accepted as Noted - Make submittals in accordance with
Specification Division 01 33 00.

_____ Substitution Rejected – Provide specified product.

_____ Substitution Request Received Too Late – Provide specified product.

By: _____ Date: _____

Remarks: _____

END OF SECTION

SECTION 01 64 00 - OWNER FURNISHED PRODUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Requirements for installing Owner-furnished products, including providing miscellaneous items and accessories for a complete, functioning installation.

1.3 RELATED SECTIONS

- A. Section 01 58 00 - Project Identification and Signage: Owner-furnished, Contractor-installed (OFCI) temporary signage.

1.4 PRODUCT HANDLING

- A. Protection: Contractor shall use means necessary to protect the materials of this Section before, during, and after installation and to protect completed Work, including products installed by others.
- B. Replacements: In the event of damage, Contractor shall immediately repair all damaged and defective Work to satisfaction of University's Representative, at no change in Contract Time and Contract Sum.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED/CONTRACTOR-INSTALLED (OFCI) PRODUCTS

- A. Products Identified with Contractor Responsibility for Installation:
 - 1. Contractor shall verify mounting and utility requirements for accepted products.
 - 2. Contractor shall provide mounting and utility rough-ins for OFCI products.
 - a. Rough-in locations, sizes, capacities and similar type shall be as indicated and required by product manufacturers.
 - b. If the University substitutes items similar to those scheduled there shall be no change in rough-in cost, unless substitution occurs after rough-in has been completed or rough-in involves other mounting requirements, utilities of different capacity than those required by item originally specified.
 - 3. For items Designated to Be Owner- or Vendor-Furnished: University or its vendor will furnish manufacturer's literature or information, shop drawings, or appropriate information for preparing required shop drawings.

- B. Installation Instructions: Approved manufacturer's printed descriptions, specifications and recommendations shall govern the Work, unless specifically indicated otherwise.
- C. Electrical Components: Contractor shall comply with requirements specified in Division 26 - Electrical, including California Electrical Code (CEC).
- D. Plumbing and HVAC Components: Contractor shall comply with requirements specified in Division 22 – Plumbing and Division 23 - HVAC, including California Plumbing Code (CPC) and California Mechanical Code (CMC).

2.2 OWNER-FURNISHED/CONTRACTOR-INSTALLED PRODUCT REQUIREMENTS

- A. Products Furnished by University and Installed by Contractor:
 - 1. Contractor shall coordinate delivery of OFCI products. University will furnish products to coincide with construction schedule.
 - 2. University will:
 - a. Furnish standard integral components of products.
 - b. Deliver products to site. Contractor shall assist University in offloading products.
 - 3. The Contractor shall:
 - a. Receive products at site and give written receipt for product at time of delivery, noting visible defects and omissions; if such declaration is not given, the Contractor shall assume responsibility for such defects and omissions.
 - b. Store products until ready for installation and protect from loss and damage.
 - c. Uncrate, assemble and set products in place.
 - d. Install products in accordance with manufacturer's recommendations, instructions and shop drawings under supervision of manufacturer's representative where specified, supplying labor and material required and making mechanical, plumbing and electrical connections necessary to operate equipment.
 - e. Where so specified, installation shall be only by installer approved by manufacturer. If known, approved installer is identified on the Drawings or in the Specifications.
 - f. Provide and install backing for all products weighing 20 pounds or more.
 - g. Treat all Owner or Vendor supplied products with the same care as all Contractor furnished items.
- B. Products Furnished and Installed by University:
 - 1. Contractor prepare; vendor install:
 - a. General: Contractor shall coordinate deliveries of vendor-supplied products. Vendor will furnish products to coincide with the construction schedule.
 - b. Vendor will:
 - 1) Furnish standard integral components of products.
 - 2) Deliver products to site.
 - 3) Make connections to roughed-in utilities.
 - c. Contractor shall:
 - 1) Receive products at site and give written notice of receipt of each product at time of delivery, noting visible defects.

- 2) Provide rough-in of utility products in accordance with manufacturer's recommendations, instructions and shop drawings under supervision of the manufacturer's representative where specified.
- 3) Provide and install backing for all products weighing 20 pounds or more.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection:

1. Prior to commencing Work, Contractor shall verify that Work specified in other Sections has been properly completed and installed as specified to allow for installation of all materials and methods required of this Section.
2. Contractor shall verify that new and existing products and conditions are satisfactory for installation or relocation of OFCI products. If unsatisfactory conditions exist, do not commence the installation until such conditions have been corrected.

B. Discrepancies:

1. In the event of discrepancy, Contractor shall immediately notify the University's Representative.
2. Contractor shall not proceed with installation in areas of discrepancy until all such discrepancies have been resolved.

3.2 INSTALLATION

- A. Contractor shall relocate and reinstall existing products in accordance with Contract Documents and reviewed shop drawings, original manufacturer's instructions and recommendations if applicable and as directed.
- B. Contractor shall install Owner-furnished products in accordance with reviewed shop drawings and manufacturer's printed instructions, as applicable.

3.3 ADJUSTING AND CLEANING

- A. Contractor shall adjust products as necessary and as directed by University's Representative.
- B. Contractor shall clean all new and relocated OFCI products.
- C. Contractor shall protect OFCI products from damage until Contract Completion.

END OF SECTION

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SECTION 01 65 00 - PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Protect products scheduled for use in the work by means including, but not necessarily limited to, those described in this Section.

1.3 RELATED SECTIONS

- A. Section 01 61 00 - Basic Product Requirements: Qualitative requirements for products.
- B. Section 01 66 00 - Product Storage and Handling Requirements: Requirements for protection of products after delivery.

1.4 QUALITY ASSURANCE

- A. Contractor's Quality Assurance: Contractor shall include within the Contractor's quality assurance program procedures as necessary to ensure protection of products upon delivery. Contractor shall be solely responsible for all products upon delivery to Work site and in off-site storage.
 - 1. Contractor shall schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Contractor shall coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Contractor shall inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
- B. Manufacturer's Requirements: Contractor shall determine and comply with manufacturer's instructions and recommendations for product handling.
- C. Packaging: Contractor shall deliver products to Work site in manufacturer's original containers, with labels intact and legible.
 - 1. Products delivered to Work site shall be in undamaged condition, in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

2. Contractor shall maintain packaged materials with seals unbroken and labels intact until time of use.
 3. Products will be subject to rejection if they do not bear required identification or are unsuitably packaged.
- D. Delivery:
1. Contractor shall address and deliver products to Project site. Do not deliver products to University campus shipping and delivery department. Address deliveries to Contractor and Project name. Do not address products "care of" University.
 2. University will not be responsible for mis-addressed and mis-delivered products, including claims for damage and delay.
- E. Damaged Products: In event of damage, Contractor shall promptly make replacements and repairs to packaging and contents, as acceptable to University's Representative, at no change in Contract Sum and Contract Time.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 66 00 - PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Storage and protection requirements to ensure that products intended for use in the Work will not be damaged and will not deteriorate from time of delivery to time of incorporation into the Work.

1.3 RELATED SECTIONS

- A. Section 01 52 00 - Construction Facilities: Requirements for storage sheds.
- B. Section 01 52 05 - Construction Staging Areas: Locations for vehicular access and staging of products during Work.
- C. Section 01 56 00 - Temporary Barriers and Enclosures: Requirements for temporary construction barriers, enclosures and passageways, applicable to protection of construction.
- D. Section 01 61 00 - Basic Product Requirements: Qualitative requirements for products.
- E. Section 01 65 00 - Product Delivery Requirements: Requirements for packaging and delivery of products.

1.4 QUALITY ASSURANCE

- A. Contractor's Quality Assurance: Contractor shall include within the Contractor's quality assurance program procedures as necessary to ensure protection of products after delivery to Work site. Contractor shall be solely responsible for all products stored on site and in off-site storage.
 - 1. Contractor shall protect stored products from damage.
 - 2. Contractor shall store products to allow for inspection and measurement of quantity or counting of units.
 - 3. Contractor shall store materials in a manner that will not endanger Project structure.
 - 4. Contractor shall store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
- B. Manufacturer's Handling Requirements: Contractor shall determine and comply with product manufacturer's written instructions for handling products.

- C. **Manufacturer's Storage Requirements:** Contractor shall determine and comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
- D. **Storage:** Contractor shall provide secure locations and enclosures at Project site for storage of materials and equipment. Contractor shall coordinate location with Contractor storage and staging areas. Refer to Section 01 52 00 - Construction Facilities and Section 01 52 05 - Construction Staging Areas.
 - 1. Contractor shall maintain packaged materials with seals unbroken and labels intact until time of use.
 - 2. Products will be subject to rejection if they do bear required identification or are unsuitably packaged.
- E. **Damaged Products:** In event of damage, Contractor shall promptly make replacements and repairs to packaging and contents, as acceptable to University's Representative, at no change in Contract Sum and Contract Time.
- F. Contractor shall not have products or materials that are intended for the Contractor delivered to the University's Receiving and Distribution Warehouse. Contractor shall make arrangements to have products and/or materials delivered directly to the work site. Products and/or materials delivered to the University's Receiving and Distribution Warehouse will not be accepted.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 72 00

PREPARATION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Requirements for preparation prior to installing, applying and placing products to determine acceptable conditions for the Work.
- B. Layout of the Work and other engineering services necessary to accomplish the Work.

1.3 RELATED SECTIONS

- A. Section 01 31 00 - Coordination: Requirements for proper sequencing and interfacing of the Work.
- B. Section 01 31 19 - Project Meetings: General requirements for pre-installation conferences.
- C. Section 01 73 29 - Cutting and Patching: Work performed to provide access for performing the Work.
- D. Section 01 77 00 - Contract Closeout Procedures: Project record documents, including layout data.
- E. Section 01 78 29 - Survey and Layout Data: Requirements for survey and layout data submittals.

1.4 LAYOUT OF WORK

- A. Surveyor: Contractor shall select and pay for services of a land surveyor, registered in the State of California, for proper performance of the Work.
 - 1. Services of surveyor shall be suitable for layout and verification of location of buildings and site elements.
 - 2. For the Project record, Contractor shall submit the name, address and telephone number of land surveyor before starting survey Work.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Manufacturer's Requirements: Contractor shall determine product manufacturer's requirements and recommendations prior to commencing Work.
- B. Preparations: Contractor shall perform preparation actions according to manufacturer's instructions and recommendations and according to specified procedures.
 - 1. Contractor shall perform surface preparation as necessary to create suitable substrates for application, installation and placement of products.
 - 2. Contractor shall notify University's Representative in writing of unsuitable conditions preventing proper

performance of the Work.

- C. Existing Utility Information: Contractor shall furnish information to serving utility 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. Contractor shall coordinate with University's Representative and with authorities having jurisdiction.
- D. Existing Utility Interruptions: Contractor shall not interrupt utilities serving facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Contractor shall notify University's Representative not less than two working days in advance of proposed utility interruptions.
 - 2. Contractor shall not proceed with utility interruptions without written permission from University's Representative.
- E. Field Measurements: Contractor shall take field measurements as required to fit the Work properly. Contractor shall recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, Contractor shall verify dimensions of other construction by field measurements before fabrication. Contractor shall coordinate fabrication schedule with construction progress to avoid delaying the Work.
- F. Space Requirements: Contractor shall verify space requirements and dimensions of items shown diagrammatically on Drawings.
- G. Review of Contract Documents and Field Conditions: Immediately upon discovery of the need for clarification of the Contract Documents, Contractor shall submit a Request for Interpretation (RFI) to Architect. Contractor shall include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Contractor shall submit requests in accordance with requirements specified in Section 01340 - Requests for Interpretation (RFI), using form as directed by University's Representative.
- H. Verification of Construction Layout: Before proceeding to lay out the Work, Contractor shall verify layout information shown on Drawings, in relation to the property survey and existing benchmarks, and locate survey reference points. If discrepancies are discovered, Contractor shall promptly notify University's Representative, Architect and Project Inspector.

3.2 FIELD ENGINEERING

- A. Examination: Contractor shall verify locations of survey control and reference points prior to starting Work. If discrepancies are discovered, Contractor shall promptly notify University's Representative, Architect and Project Inspector.
- B. Survey Control and Reference Points: Contractor shall locate and protect survey control and reference points. Control datum for survey shall be as indicated on Civil Drawings. Notwithstanding the data on Civil Drawings, Contractor shall use NAD 83 State Plane Coordinate System for survey control and reference points.
 - 1. Business and Professions Code section 8771 provides for the preservation of Survey Monuments in construction projects. This legislation mandates that, prior to construction, monuments shall be referenced in the field and "Corner Records" shall be prepared for filing in the Office of the County Surveyor. Contractor shall ensure that these shall be performed prior to Contract Completion of the Work.
 - 2. Contractor shall comply with requirements of authorities having jurisdiction for survey monument preservation on capital improvement projects where monument points are present.
 - 3. Contractor shall be responsible for preparing and submitting proper documentation to the Office of the County Surveyor in compliance with Business and Professions Code section 8771.

4. Contract Completion and release of retainage shall be contingent upon obtaining documentation from Contractor's project surveyor or engineer that monuments have been set or restored and that Corner Records have been filed with and to the satisfaction of the County Surveyor.
5. All costs and actions necessary for compliance with Business and Professions Code section 8771 shall be included in the Contract Sum and Contract Time.

3.3 SURVEYING AND FIELD ENGINEERING SERVICES

- A. Surveying and Field Engineering Services: Contractor shall provide surveying and field engineering services as necessary for performance of the Work. Refer to Section 01 78 29 - Survey and Layout Data.
 1. Contractor shall be responsible for the accuracy and adequacy of surveying and field engineering services.
 2. Contractor shall utilize recognized engineering practices.
 3. Contractor shall check the location, level and plumb, of every major element as the Work progresses.
 4. Contractor shall preserve construction survey stakes and marks for the duration of their usefulness.
 5. If construction survey stakes are lost or disturbed, and require replacement, Contractor shall perform replacement at no change in Contract Sum and Contract Time.
 6. Contractor shall excavate all holes necessary for line and grade stakes.
- B. Surveying for Layout and Control of the Work: Contractor shall establish elevations, lines and levels for all Work under the Contract. Contractor shall locate and lay out by instrumentation and similar appropriate means:
 1. Site improvements, including pavements, curbs, headers, sewers, storm drains, structures, and paving. Note on Project Record Drawings utility locations, slopes and invert elevations.
 2. Stakes for cutting, filling, grading and topsoil placement, to establish finished grade or flow line indicated on Contract Drawings.
 - a. Contractor shall preserve construction survey stakes and marks for the duration of their usefulness.
 - b. If construction survey stakes are lost or disturbed, and require replacement, Contractor shall perform replacement at no change in Contract Sum and Contract Time.
 - c. Contractor shall excavate all holes necessary for line and grade stakes.
 3. Grid or axis for structures, building foundation, column locations and ground floor elevations.
 4. Contractor shall establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 5. Contractor shall establish dimensions within tolerances indicated. Contractor shall not scale Drawings to obtain required dimensions.
 6. Contractor shall inform installers of lines and levels to which they must comply.
 7. When deviations from required lines and levels exceed allowable tolerances, Contractor shall notify University's Representative, Architect and Project Inspector.
 8. Contractor shall close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Monuments: Contractor shall establish a minimum of two permanent monuments on site, referenced to established control points. Contractor shall record locations, with horizontal and vertical data, on Project Record

Drawings.

1. In accordance with Business and Professions Code section 8772, any monument set by a licensed land surveyor or registered civil engineer to mark or reference a point on a property or land line shall be permanently and visibly marked or tagged with the certificate number of the surveyor or civil engineer setting it, each number preceded by the letters "L.S." or "R.C.E." respectively, as the case may be, or, if the monument is set by a public agency, it shall be marked with the name of the agency and the political subdivision it serves.
 2. Nothing in this Section shall prevent the inclusion of other information on the tag which will assist in the tracing or location of survey records which relate to the tagged monument.
 3. Contractor shall ensure that centerline ties filed with the County Surveyor will be checked for compliance with this law.
- D. Site Grading Verification: Upon completion of grading, Contractor shall survey graded areas and establish that elevations are correct and within acceptable tolerances for paving and finish grading.
- E. Verification of Work: Contractor shall periodically verify layout and completed conditions of the Work by same means.

END OF SECTION

SECTION 01 73 00

EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. General requirements for installing, applying and placing products.
- B. General requirements for correction of defective Work.

1.3 RELATED SECTIONS

- A. Section 01 31 19 - Project Meetings: Pre-installation and coordination conferences where procedures for installing, applying and placing products are reviewed prior to performance of the Work.
- B. Individual Division 2 through 49 Product Specification Sections: Specific requirements for installing, applying and placing products.

1.4 EXECUTION

- A. Manufacturer's Requirements: Contractor shall determine product manufacturer's requirements and recommendations prior to commencing Work.
- B. Execution: Contractor shall perform installation, application and placement actions according to manufacturer's instructions and recommendations and according to specified procedures.
 - 1. Contractor shall perform surface preparation as necessary to create suitable substrates for application, installation and placement of products.
 - 2. Contractor shall notify University's Representative in writing of unsuitable conditions preventing proper performance of the Work.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

3.1 INSTALLATION, APPLICATION AND PLACEMENT OF PRODUCTS

- A. Manufacturer's Instructions: Contractor shall comply with manufacturer's written instructions and recommendations for installing, applying, placing and finishing products.
- B. Installation, Application and Placement, General: Contractor shall locate the Work and components of the Work accurately, in correct alignment, orientation and elevation, as indicated.
 - 1. Contractor shall make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, Contractor shall install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Contractor shall conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 - 4. Contractor shall maintain minimum headroom clearance of 80" in all spaces, unless otherwise directed.

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5. Contractor shall install products at the time and under conditions that will ensure the best possible results. Contractor shall maintain conditions required for product performance until acceptance of the Work.
 6. Contractor shall 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.
- C. Tools and Equipment: Contractor shall not use tools or equipment that produce harmful noise levels. Refer to Section 01 14 00 – Work Restrictions
- D. Anchors and Fasteners: Contractor shall provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
1. Mounting Heights: Where mounting heights are not indicated, Contractor shall mount components at heights directed by Architect.
 2. Contractor shall allow for building movement, including thermal expansion and contraction.
- E. Joints: Contractor shall make joints of uniform width. Where joint locations in exposed work are not indicated, Contractor shall arrange joints for the best visual effect. Contractor shall fit exposed connections together to form hairline joints.
- F. Hazardous Materials: Contractor shall use products, cleaners, and installation materials that are not considered hazardous.
- G. Cleaning: Contractor shall comply with requirements specified in Section 01 74 00 - Cleaning Requirements. See individual product Specifications Sections for specific cleaning procedures to be performed.
- H. Protection: Contractor shall provide barriers, covers and other protective devices as recommended by manufacturer and complying with general requirements specified in Section 01 56 00 - Temporary Barriers and Enclosures.
1. Contractor shall comply with manufacturer's written instructions for temperature and relative humidity.
 2. See individual product Specifications Sections for specific protective measures to be provided.
- I. Limiting Exposures: Contractor shall supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.2 OWNER-INSTALLED PRODUCTS

- A. Site Access: Contractor shall provide access to Project site for University's construction forces and those performing work for University under separate contracts. Contractor shall coordinate with requirements specified in Section 01 55 00 - Vehicular Access and Parking.
- B. Coordination: Contractor shall coordinate construction and operations of the Work with work performed by University by separate contract or with University's construction forces.
1. Construction schedule: Contractor shall inform University's Representative of Contractor's preferred construction schedule for University-installed work. Contractor shall adjust construction schedule based on a mutually agreeable timetable. Contractor shall notify University's Representative if changes to schedule are required due to differences in actual construction progress.
 2. Pre-installation and coordination conferences: Contractor shall include University's construction forces at pre-installation and coordination conferences covering portions of the Work that are to receive University-installed work. If portions of the Work depend on University-installed products, Contractor shall attend pre-installation conferences conducted by University's construction forces.

3.3 CORRECTION OF THE WORK

- A. Correction of the Work, General: Contractor shall repair or remove and replace defective construction. Contractor shall restore damaged substrates and finishes to match original and new surrounding construction.

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1. Contractor shall comply with requirements in Section 01 73 29 - Cutting and Patching Procedures.
 2. Repairing shall include replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
 3. Contractor shall remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
 4. Contractor shall repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
 5. Contractor shall remove and replace chipped, scratched, and broken glass.
- B. Restoration of Existing Conditions: Contractor shall restore permanent facilities used during construction to their original condition or to match new construction.

END OF SECTION

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SECTION 01 73 29

CUTTING AND PATCHING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Requirements and procedural requirements for cutting and patching, including:
 - 1. Cutting and patching not required to be performed as part of the Work specified in other Sections.
 - 2. Cutting and patching existing construction altered or disturbed to accommodate new construction.
 - 3. Cutting and patching existing construction damaged or defaced during new construction as required to restore to existing or better condition at the time of award of Contract.
 - 4. Cutting and patching required to:
 - a. Install or correct non-coordinated Work.
 - b. Remove and replace defective and non-conforming Work.
 - c. Remove samples of installed Work for testing.
- B. Refer to other Sections and drawings for specific requirements of the extent and limitations applicable to cutting and patching, demolishing, or altering existing construction of individual parts of the Work.
 - 1. Requirements of this Section also apply to plumbing mechanical and electrical installations. (Refer to Division-22, Division 23 and Division-26 Sections for other requirements and limitations applicable to cutting and patching plumbing, mechanical and electrical installations).

1.3 RELATED SECTIONS

- A. Section 01 11 00 - Summary of the Work: Work by University's construction forces or by others under separate contract with University.
- B. Section 01 56 00 - Temporary Barriers and Enclosures: Dust-control barriers at cutting and patching locations.
- C. Section 01 74 00 - Cleaning Requirements: Cleaning after cutting and patching Work.
- D. Section 02 41 13 - Selective Demolition: Cutting and removal of existing construction.
- E. Individual Division 2 through 48 Product Specification Sections:
 - 1. Cutting and patching incidental to Work specified in the Section.
 - 2. Coordination with Work specified in other Sections for openings required to accommodate Work specified in those other Sections.

1.4 SUBMITTALS

- A. Written Requests for Cutting and Alteration: Coordinate with requirements specified in [*Section 02 41 13 - Selective Demolition*] [*Section* [*No.*] - [____]].
 - 1. Contractor shall submit written request in advance of cutting or alteration which affects:
 - a. Structural integrity of any element of new or existing construction.
 - b. Integrity of weather-exposed or moisture-resistant elements.
 - c. Efficiency, maintenance, or safety of operational elements.
 - d. Visual qualities of elements exposed to view in the completed construction.
 - e. Work by University's construction forces or by others under separate contract with University.
 - f. Existing construction not otherwise indicated to be revised by Work under the Contract.
 - 2. Contractor shall include in requests for cutting and alteration:
 - a. Identification of Project.

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- b. Location and description of affected Work. Include shop drawings as necessary to identify locations and communicate descriptions.
 - c. Explanation of necessity for cutting and patching.
 - d. Description of proposed Work and products to be used.
 - e. Alternatives to cutting and patching.
 - f. Effect on existing construction.
 - g. Effect on work by University's construction forces or by separate contractors performing work for University.
3. Contractor shall include written evidence that those performing work under separate contract for University have been notified and acknowledge that cutting and patching work will be occurring. Contractor shall include written permission for intended cutting and patching, included scheduled times.
 4. Contractor shall indicate date and time cutting and patching Work will be performed, including duration.
 5. Contractor shall describe the extent of cutting and patching required and how it is to be performed.
 6. Contractor shall describe anticipated results in terms of changes to existing construction; include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
 7. Contractor shall list products to be used and firms or entities that will perform work.
 8. Contractor shall list utilities that will be disturbed or affected, including those that will be relocated and those that will be temporarily out-of-service. Contractor shall indicate how long service will be disrupted.
 9. Where cutting and patching involves addition of reinforcement to structural elements, Contractor shall submit details to show how reinforcement is integrated with the original structure.
 10. Approval by the Architect to proceed with cutting and patching does not waive the Architect's right to later require complete removal and replacement of a part of the Work found to be unsatisfactory.
 11. Contractor shall minimize effects on University operations and on concurrent operations construction by other contractors.

1.5 QUALITY ASSURANCE

- A. Requirements for Structural Work: Contractor shall not cut and patch structural elements in a manner that would reduce their load-carrying capacity or load-deflection ratio.
 1. Contractor shall obtain approval from the Architect of the cutting and patching proposal before cutting and patching the following structural elements:
 - Bearing and retaining walls
 - Structural concrete
 - Structural steel
 - Lintels
 - Timber and primary wood framing
 - Structural decking
 - Stair systems
 - Miscellaneous structural metals
 - Equipment supports
 - Piping, ductwork, vessels and equipment
- B. Operational and Safety Limitations: Contractor shall not cut and patch operating elements or safety-related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance, or decreased operational life or safety.
 1. Contractor shall obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety-related systems:

- Primary operational systems and equipment
- Air or smoke barriers
- Water, moisture, or vapor barriers
- Membranes and flashings
- Fire protection systems
- Noise and vibration control elements and systems
- Control systems
- Communication systems
- Electrical wiring systems

- C. Visual Requirements: Contractor shall not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in the Architect's opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching. Contractor shall remove and replace work cut and patched in a visually unsatisfactory manner.
- D. If possible Contractor shall retain the original installer or fabricator throughout construction phases to cut and patch the following categories of exposed work, or if it is not possible to engage the original installer or fabricator, Contractor shall engage another recognized experienced and specialized firm:
 - Concrete finishes
 - Masonry
 - Stucco and ornamental plaster
 - Acoustical ceilings
 - Painting
 - Wall covering
 - HVAC enclosures, cabinets or covers

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Patching Materials, General: As required for original installation and to match surrounding construction.
 - 1. Contractor shall provide same products or types of construction as that in existing structure, as needed to patch, extend or match existing.
 - 2. Generally the Contract Documents will not define products or standards of workmanship present in existing construction; Contractor shall determine products by inspection and necessary testing, and determine quality of workmanship by using existing as a sample for comparison.
 - 3. The presence of a product, finish, or type of construction requires that patching, extending or matching shall be performed as necessary to make work complete and consistent with identical standards of quality.
- B. Patching at Paving: At Portland cement concrete (PCC) paving, Contractor shall use concrete mix with maximum 3/8-inch aggregate and minimum 3000 psi 28-day compressive strength. Contractor shall provide dowels to existing paving with min. 6" penetration into existing surface and reinforce new paving with minimum No. 3 reinforcing steel bars at 16-inches on center each way placed in the vertical center of the slab. Welded wire fabric reinforcement will not be acceptable.
 - 1. All PCC paving shall be cut and patched from score line to score line and shall match as closely as possible in color and texture of the adjacent finish.
- C. Patching of Lawns and Grasses: Contractor shall restore areas trenched, disturbed or damaged. Contractor shall provide sod or seeded planting mix, to match existing lawn or grass area. Contractor shall properly barricade the area until such time as the planting mix establishes. Refer to sections 01 59 39 – Tree and Plant Protection
- D. Patching of Building Finish Materials: Contractor shall match existing products and finishes. Contractor shall confirm colors, patterns and textures with Architect. Contractor shall custom cut new materials to fit and to match joint patterns with existing materials.
 - 1. Ceramic tile and acoustical panels: Contractor shall custom cut new materials to size to match existing construction.

- E. Product Substitutions: For each proposed change in materials, Contractor shall submit request for substitution under provisions of Section 01 61 00 - Basic Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examination, General: Before cutting existing surfaces, Contractor shall examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed. Contractor shall take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered. Contractor shall inspect existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.
 - 1. Before proceeding, Contractor shall meet at the site with parties involved in cutting and patching, including asbestos abatement, mechanical and electrical trades. Contractor shall review areas of potential interference and conflict. Contractor shall coordinate procedures and resolve potential conflicts before proceeding.
 - 2. Beginning of cutting or patching shall be interpreted to mean that existing conditions were found by Contractor to be acceptable.
 - 3. After uncovering existing Work, Contractor shall inspect conditions affecting proper accomplishment of Work.

3.2 PREPARATION

- A. Temporary Supports: Contractor shall provide supports to ensure structural integrity of the Work. Contractor shall provide devices and methods to protect other portions of Project from damage.
- B. Protection: Contractor shall protect existing construction during cutting and patching to prevent damage. Contractor shall provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- C. Contractor shall avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Contractor shall take all precautions necessary to avoid cutting existing pipe, conduit or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them.
- E. Weather Protection: Contractor shall provide protection from elements for areas which may be exposed by uncovering Work. Contractor shall maintain excavations free of water.

3.3 CUTTING AND PATCHING

- A. Cutting and Patching, General: Contractor shall execute cutting, fitting, and patching, excavation and fill, as necessary to complete the Work. Contractor shall employ skilled workers to perform cutting and patching. Contractor shall proceed with cutting and patching at the earliest feasible time and complete without delay. Contractor shall:
 - 1. Coordinate installation or application of products for integrated Work. Avoid having to cut and patch new substrates and finishes.
 - 2. Uncover completed Work as necessary to install or apply products out of sequence.
 - 3. Cut, remove and replace defective and non-conforming Work.
 - 4. Cut and patch as necessary to provide openings in the Work for penetration of plumbing, fire protection, HVAC and electrical Work.
 - 5. Where partitions are removed, patch floors, walls, and ceilings with finish materials to match existing.
 - a. Where removal of partitions results in adjacent spaces becoming one, re-work floors and ceilings to provide smooth and clean planes without breaks, steps, or bulkheads.
 - b. Where extreme change of plane of one inch or more occurs, request instructions from Architect as to method of making transition.

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6. Trim and refinish existing doors as necessary to clear new floor finishes.
 7. By-pass utility services such as pipe or conduit, before cutting, where services are shown or required to be removed, relocated or abandoned. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting. Update as-built set with photographs or notations for the actual conditions.
- B. Cutting: Contractor shall:
1. Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review proposed procedures with the original installer; comply with the original installer's recommendations. Provide appropriate surfaces to receive final finishing. It is recommended to photograph the existing condition prior to cutting. This photo record shall serve as the pre-cut condition for comparison to the final patched outcome.
 2. Execute cutting and patching of weather-exposed, moisture-resistant elements and surfaces exposed to view by methods to preserve weather, moisture and visual integrity.
 3. Cut rigid materials using carbide tip saw blades, diamond grit abrasive saw blades, diamond core drills and hole saws, and similar cutters for smooth edges. Do not overcut corners.
 - a. Core drill holes through concrete and masonry.
 - b. Pneumatic tools will not be allowed without prior approval.
 4. Provide fire and smoke seals at new penetrations to maintain fire rating at all penetrations.
 5. Confirm and comply with all Asbestos and lead containing/lead based paint remedial procedures listed in Section 01 35 01 – Hazardous Material Procedures prior to any disturbance of any existing material.
- C. Patching: Contractor shall patch with durable seams that are as invisible as possible. Contractor shall comply with specified tolerances. Contractor shall restore substrates and finishes with products to match existing construction and as specified in product Sections of the Specifications for new construction. Contractor shall:
1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
 2. 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.
 3. Where removal of walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance.
 - a. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken containing the patch, after the patched area has received primer and second coat.
 4. Patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.
 5. Finish surfaces flush and textured to match surrounding finishes.
 6. Fit work neat and tight allowing for expansion and contraction.
 7. Butt new finished to existing exposed structure, pipes, ducts, conduit, and other penetrations through surfaces.
- D. Finishing: Contractor shall refinish surfaces to match adjacent and similar finishes as used for the Project.
1. For continuous surfaces, Contractor shall refinish to nearest intersection or natural break.
 2. For an assembly, Contractor shall refinish entire unit.
- E. Penetrations at Fire-Rated Construction: At penetrations of fire rated walls, partitions, ceiling, or floor construction, Contractor shall completely seal voids with firestopping and smoke seal material in compliance with an applicable UL-listed assembly, to full thickness of the penetrated element. Refer to [Section 07 84 00 - Firestopping] [Section [No.] - [TITLE]].
- F. Restoration and Finishing: Contractor shall finish surfaces to match adjacent and similar finishes as used for the Project.
1. Contractor shall restore Work with new products as specified in individual product Specifications Sections in Divisions 07 and 09.
 2. Contractor shall patch and replace any portion of an existing finished surface which is found to be damaged, lifted, discolored, or shows other imperfections, with matching material. Contractor shall:

- a. Provide adequate support of substrate prior to patching the finish.
 - b. Refinish patched portions of painted or coated surfaces in a manner to produce uniform color and texture over the entire surface.
 - c. When existing surface finish cannot be matched, refinish entire surface to nearest intersections.
- G. Transition from Existing to New Construction:
1. When new work abuts or finishes flush with existing work, Contractor shall make a smooth and clean transition. Contractor shall patched work shall match existing adjacent work in texture and appearance so that the patch or transition is invisible at a distance of five feet.
 2. When finished surfaces are cut in such a way that a smooth and clean transition with the new work is not possible, Contractor shall notify Architect. Contractor shall terminate existing surface in a neat manner along a straight line at a natural line of division, and provide trim appropriate to finished surface, or as otherwise directed by Architect.
- H. Plaster Installation: Contractor shall comply with manufacturer's instructions and install thickness and coats as indicated.

3.4 CLEANING

- A. Cleaning: Contractor shall thoroughly clean areas and spaces where cutting and patching is performed or used as access. Contractor shall remove completely paint, mortar, oils, putty and items of similar nature. Contractor shall thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Contractor shall restore damaged pipe covering to its original condition.

END OF SECTION

SECTION 01 74 00 - CLEANING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Cleaning during construction.
- B. Cleaning for Contract Completion review and final acceptance of the Work.

1.3 RELATED SECTIONS

- A. Additional Requirements: Cleaning for specific products or elements of Work are described in individual product Specification Sections in Divisions 2 through 49. Contractor shall comply also with University's Contractor Safety Handbook.

1.4 SUBMITTALS

- A. Product List: Contractor shall submit complete list of all cleaning agents and materials for University's Representative's review and approval.
- B. Cleaning Procedures: Contractor shall submit description of cleaning processes, agents and materials to be used for final cleaning of the Work. Processes and degree of cleanliness shall be as directed by University's Representative. All cleaning processes, agents and materials shall be subject to University's Representative's review and approval.

1.5 QUALITY ASSURANCE

- A. Cleaning and Disposal Requirements, General: Contractor shall conduct cleaning and disposal operations in compliance with all applicable codes, ordinances and regulations, including environmental protection laws, rules and practices.
- B. Cleaning Workers: Contractor shall employ experienced workers or professional cleaners for final cleaning. Contractor shall clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Contractor shall comply with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents and Materials: Contractor shall use only those cleaning agents and materials which will not create hazards to health or property and which will not damage or degrade surfaces. Contractor shall:
 - 1. Use only those cleaning agents, materials and methods recommended by manufacturer of the material to be cleaned.
 - 2. Use cleaning materials only on surfaces recommended by cleaning agent manufacturer.

PART 3 - EXECUTION

3.1 CLEANING DURING CONSTRUCTION

- A. Garbage Control: Contractor shall control accumulation of debris, waste materials and rubbish. Contractor shall leave the site each day clean and neat. Contractor shall dispose of debris, waste and rubbish off-site in a legal manner.
- B. Cleaning, General: Contractor shall clean sidewalks, driveways and streets frequently to maintain public thoroughfares free of dust, debris and other contaminants. This shall be at no cost to the University.
- C. Cleaning of Existing Facilities: Contractor shall clean surfaces in existing buildings where alteration and renovation Work is being performed or where other construction activities have caused soiling and accumulation of dust and debris. Contractor shall:
 - 1. Clean dust and soiling from floor surfaces.
 - 2. Clean dust from horizontal and vertical surfaces, including lighting fixtures.
 - 3. Replace HVAC filters.
- D. Parking Area Cleaning: Contractor shall keep parking areas clear of construction debris, especially debris hazardous to vehicle tires.
- E. Thoroughfare Clearing and Cleaning: Contractor shall keep site accessways, parking areas and building access and exit facilities clear of mud, soiling and debris. Contractor shall:
 - 1. Remove mud, soil and debris and dispose in a manner which will not be injurious to persons, property, plant materials and site.
 - 2. Comply with runoff control requirements stated above and as required by governing authorities having jurisdiction.
- F. Cleaning Frequency: At a minimum, Contractor shall clean Work areas and site daily. Contractor shall leave the site each day clean and neat.
- G. Failure to Clean: At any point during the course of Work, should cleaning by Contractor not be sufficient or acceptable to University's Representative, especially regarding paths of travel, University may engage cleaning service to perform cleaning and deduct costs for such cleaning from sums owed to Contractor.

3.2 CONTRACT COMPLETION REVIEW CLEANING, GENERAL

- A. Contract Completion Review Cleaning, General: Contractor shall execute a thorough cleaning prior

to Contract Completion review by University's Representative and Architect. Contractor shall complete final cleaning before submitting final Application for Payment. Contractor shall:

1. Conduct cleaning in compliance with regulations of authorities having jurisdiction and industrial safety standards for cleaning.
2. Employ professional building cleaners to thoroughly clean building.
3. Complete cleaning operations specified below before requesting inspection for Certification of Completion. Contractor shall:
 - a. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
 - b. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
 - c. Clean the site, including landscape development areas, of rubbish, litter and foreign substances. Sweep paved areas broom clean; remove stains, spills and other foreign deposits.

B. Waste Disposal, Contractor shall:

1. Remove waste materials from the site and conduct disposal in a lawful manner.
2. Do not burn waste materials.
3. Do not bury debris or excess materials on the University property.
4. Do not discharge volatile, harmful or hazardous materials into drainage systems.
5. Where extra materials of value remaining after completion of associated work have become the University's property, arrange for disposition of these materials as directed.

3.3 INTERIOR CLEANING

A. Interior Cleaning, Contractor shall:

1. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program.
2. Remove labels that are not permanent labels.
3. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from all visible interior and exterior surfaces.
4. Remove dust from all horizontal surfaces not exposed to view, including light fixtures, ledges and plumbing fixtures.
5. Clean all horizontal surfaces to dust-free condition, including tops of door and window frames, tops of doors and interiors of cabinets and casework.
6. Remove waste and surplus materials, rubbish and temporary construction facilities, utilities and controls.

B. Accessories and Fixtures Cleaning: Contractor shall clean building accessories, including toilet partitions, fire extinguisher cabinets, lockers and toilet accessories, all plumbing fixtures and all lighting fixture lenses and trim.

C. Glass and Mirror Cleaning: Contractor shall clean and polish all glass and mirrors as specified in all Division 08 specifications. Contractor shall remove glazing compound and other substances that are noticeable vision-obscuring materials. Contractor shall replace chipped or broken glass and other damaged transparent materials.

- D. Metalwork: Contractor shall clean and buff all metalwork, to be free of soiling and fingerprints. Mirror finished metalwork shall be buffed to high luster.
- E. Floor Cleaning: Contractor shall clean floors to dust-free condition, free of stains, films and similar foreign substances.
 - 1. Exposed concrete floors: Contractor shall thoroughly sweep and wet mop floors in enclosed spaces. Contractor shall mop concrete floors and, at concrete floors in occupied spaces, apply floor finish as specified for resilient flooring. At unoccupied spaces, Contractor shall leave concrete floors broom clean.
 - 2. Ceramic tile flooring: Contractor shall thoroughly sweep and mop tile flooring. Contractor shall comply with specific requirements in tile and installation materials manufacturers for cleaning materials.
 - 3. Resilient flooring: Contractor shall thoroughly sweep all resilient flooring. Contractor shall damp wash and wax (as appropriate) all resilient flooring. Contractor shall comply with specific requirements in applicable resilient flooring Sections, and notes of the Drawings.
 - 4. Carpet cleaning: Contractor shall comply with accepted industry practices for cleaning commercial carpet, subject to review and acceptance by University's Representative. Contractor shall vacuum, spot clean and generally clean carpet using commercial carpet cleaning solution, scrubbers and solution extraction-type vacuuming equipment.
- F. Ventilation System Cleaning: Contractor shall replace filters and clean heating and ventilating equipment used for temporary heating, cooling and ventilation.

3.4 EXTERIOR CLEANING

- A. Building Exterior Cleaning: Contractor shall clean exterior of adjacent facilities where construction activities have caused soiling and accumulation of dust and debris. Contractor shall:
 - 1. Remove labels that are not permanent labels.
 - 2. Wash down exterior surfaces to remove dust.
 - 3. Clean exterior surfaces of mud and other soiling.
 - 4. Clean exterior side of windows, storefronts and curtainwalls, including window framing.
- B. Glass and Mirror Cleaning: Contractor shall clean and polish all glass and mirrors as specified in all Division 08 specifications. Contractor shall remove glazing compound and other substances that are noticeable vision-obscuring materials. Contractor shall replace chipped or broken glass and other damaged transparent materials.
- C. Site Cleaning: Contractor shall broom clean exterior paved surfaces. Contractor shall rake clean other surfaces of the grounds. Contractor shall:
 - 1. Wash down and scrub where necessary all paving soiled as a result of construction activities. Thoroughly remove mortar droppings, paint splatters, stains and adhered soil.
 - 2. Remove from the site all construction waste, unused materials, excess soil and other debris resulting from the Work. Legally dispose of waste.

3.5 PEST CONTROL

- A. Pest Control: Contractor shall engage an experienced, licensed exterminator to inspect and rid the project area of insects, rodents and other pests. Pests shall not be allowed to roost, nest or otherwise inhabit the Work at any point during construction. All animal/insect debris shall be promptly cleaned and disposed of in accordance with all applicable regulations to prevent surfaces becoming stained, or compromised in any manner.
 - 1. Exterminator shall prepare and submit report of inspection and extermination.
 - 2. Extermination materials shall comply with applicable pest control regulations and not leave toxic residue harmful to humans.

3.6 CLEANING INSPECTION

- A. Cleaning Inspection: Prior to Final Payment or acceptance by University for partial occupancy or beneficial use of the premises, Contractor and University's Representative shall jointly conduct an inspection of interior and exterior surfaces to verify that entire Work is acceptably clean. Punchlist shall be utilized for recording any deficiencies.
- B. Inadequate Cleaning: Should final cleaning be inadequate, as determined by University's Representative, and Contractor fails to correct conditions, University may engage cleaning service under separate contract and deduct cost from Contract Sum.

END OF SECTION

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01 74 19 – Construction Waste Management – Instruction to Project Manager

For each facility renovation project, the Project Manager will coordinate with the contractor or personnel to discuss the scope of the renovation.

- The scope of the renovation must be determined and the materials to be used and discarded during the renovation must be identified. Packaging will be a consideration in the materials that will be discarded.
- The approximate volume of each type of waste will be broken out. Separate categories may include cardboard, wood products and cabinetry, drywall, tile, etc.
- From this material flow, the five largest waste categories will be determined.
 - The Project Manager will coordinate proper waste disposal and landfill diversion for these waste categories. This will involve contacting the appropriate vendors, scheduling haul dates, and ensuring properly sized storage areas for the construction waste.
 - If necessary, a separate secured storage area will be secured for hazardous waste, such as paint.
 - Once the waste disposal has been coordinated, the renovation manager will write waste disposal instructions for each waste category and will distribute to the appropriate vendors.
- For regular maintenance activities, the facility manager will ensure that the proper materials are recycled or composted.

For all work, including renovation and maintenance, document solid waste disposal and diversion. Include the quantity by weight of waste generated; waste diverted through sale, reuse, or recycling; and waste disposed by landfill or incineration. Identify landfills, recycling centers, waste processors, and other organizations that process or receive the solid waste.

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SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes requirements and procedures for ensuring optimal diversion of construction and demolition (C&D) waste materials generated by the Work from landfill disposal within the limits of the Construction Schedule and Contract Sum.
 1. California State law (Public Resources Code sections 40000 *et seq.*) requires the California State University to develop source reduction, re-use, recycling, and composting programs to divert 75% of all solid waste from landfill disposal by 2020. Construction waste materials generated by the Work are targeted to achieve and maintain these diversion rates.
 2. The Work of this Contract requires that a minimum of 75% by weight of the construction and demolition materials generated in the Work is diverted from landfill disposal through a combination of re-use and recycling activities.
 3. For LEED® projects, requirements for submittal of LEED documentation in compliance with the Materials and Resources category, Construction and Demolition Waste Management credit.
 4. Requirements for submittal of Contractor's Construction Waste and Recycling Plan prior to the commencement of the Work.
 5. Contractor's quantitative reports for construction waste materials as a condition of approval of the third progress payment.

1.3 DEFINITIONS

- A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial, and industrial waste, resulting from construction, remodeling, repair, and demolition operations. A Class III landfill must have a solid waste facilities permit from CalRecycle and is regulated by the Enforcement Agency (EA).
- B. Construction and Demolition Debris: Building materials and solid waste resulting from construction, remodeling, repair, cleanup, or demolition operations that are not hazardous as defined in California Code of Regulations, Title 22, and Section 66261.3 *et seq.* This term includes, but is not limited to, asphalt concrete, Portland cement concrete, brick, lumber, gypsum wallboard, cardboard and other associated packaging, roofing material, ceramic tile, carpeting, plastic pipe, and steel. The debris may be commingled with rock, soil, tree stumps,

and other vegetative matter resulting from land clearing and landscaping for construction or land development projects.

- C. C&D Recycling Center. A facility that receives only C&D material that has been separated for reuse prior to receipt, in which the residual (disposed) amount of waste in the material is less than 10% of the amount separated for reuse by weight.
- D. Disposal. Final deposition of construction and demolition or inert debris into land, including stockpiling onto land of construction and demolition debris that has not been sorted for further processing or resale, if such stockpiling is for a period of time greater than 30 days; and construction and demolition debris that has been sorted for further processing or resale, if such stockpiling is for a period of time greater than one year, or stockpiling onto land of inert debris that is for a period of time greater than one year.
- E. Enforcement Agency. Enforcement agency as defined [i.e. in Public Resources Code 40130].
- F. Inert Disposal Facility or Inert Waste Landfill: A disposal facility that accepts only inert waste such as soil and rock, fully cured asphalt paving, uncontaminated concrete (including fiberglass or steel reinforcing rods embedded in the concrete), brick, glass, and ceramics, for land disposal.
- G. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.
- H. Mixed Debris Recycling Facility: A processing facility that accepts loads of commingled construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing the non-recyclable residual materials.
- I. Recycling: The process of sorting, cleansing, treating and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.
- J. Reuse. The use, in the same or similar form as it was produced, of a material which might otherwise be discarded.
- K. Separated for Reuse. Materials, including commingled recyclables, that have been separated or kept separate from the solid waste stream for the purpose of additional sorting or processing those materials for reuse or recycling in order to return them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace, and includes materials that have been "source separated."
- L. Solid Waste: All putrescible and non-putrescible solid, semisolid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, dewatered, treated, or chemically fixed sewage sludge which is not hazardous waste, manure, vegetable or animal solid and semisolid wastes, and other discarded solid and semisolid wastes. "Solid waste" does not include hazardous waste, radioactive waste, or medical waste as defined or regulated by State law.

- M. Source-Separated: Materials, including commingled recyclables, that have been separated or kept separate from the solid waste stream at the point of generation for the purpose of additional sorting or processing of those materials for reuse or recycling in order to return them to the economic mainstream in the form of raw materials for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace.
- N. Waste Hauler: A company that possesses a valid permit from the local waste management authority to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal in the locality.

1.4 SUBMITTALS

- A. Contractor's Construction Waste and Recycling Plan
 - 1. Review Contract Documents and estimate the types and quantities of materials under the Work that are anticipated to be feasible for on-site processing, source separation for re-use or recycling. Indicate the procedures that will be implemented in this program to effect jobsite source separation, such as, identifying a convenient location where dumpsters would be located, putting signage to identify materials to be placed in dumpsters, etc.
 - 2. Prior to commencing the Work, submit Contractor's Construction Waste and Recycling Plan. Submit in format provided (**Section 01 74 19A**). The Plan must include, but is not limited to the following:
 - a. Contractor's name and project identification information;
 - b. Procedures to be used;
 - c. Materials to be re-used and recycled;
 - d. Estimated quantities of materials;
 - e. Names and locations of re-use and recycling facilities/sites;
 - f. Tonnage calculations that demonstrate that Contractor will re-use and recycle a minimum 65% by weight of the construction waste materials generated in the Work.
 - 3. Contractor's Construction Waste and Recycling Plan must be approved by the Construction Administrator prior to the start of Work.
 - 4. Contractor's Construction Waste and Recycling Plan will not otherwise relieve the Contractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures.
- B. Contractor's Reuse, Recycling, and Disposal Report
 - 1. Submit Contractor's Reuse, Recycling, and Disposal Report on the form provided (**Section 01 74 19B**) with each application for progress payment. Failure to submit the form and its supporting documentation will render the application for progress payment incomplete and delay progress payments. If applicable, include manifests, weight tickets, receipts, and invoices specifically identifying the Project for re-used and recycled materials:
 - a. Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick).

- b. Salvaging building materials or salvage items at an off-site salvage or reuse center (i.e. lighting, fixtures).
 - c. Recycling source separated materials on site (i.e. crushing asphalt/ concrete for base course, or grinding for mulch).
 - d. Recycling source separated material at an offsite recycling center (i.e. scrap metal or green materials).
 - e. Use of material as Alternative Daily Cover (ADC) at landfills.
 - f. Delivery of soils or mixed inert material to an inert landfill for disposal (inert fill).
 - g. Disposal at a landfill or transfer station (where no recycling takes place).
 - h. Other (describe).
 2. Contractor's Reuse, Recycling, and Disposal Report must quantify all materials generated in the Work, disposed in [Class III] landfills, or diverted from disposal through recycling. Indicate zero (0) if there is no quantity to report for a type of material.
 3. As indicated on the form:
 - a. Report disposal or recycling either in tons or in cubic yards: if scales are available at disposal or recycling facility, report in tons; otherwise, report in cubic yards. Report in units for salvage items when no tonnage or cubic yard measurement is feasible.
 - b. Indicate locations to which materials are delivered for reuse, salvage, recycling, accepted as daily cover, inert backfill, or disposal in landfills or transfer stations.
 - c. Provide legible copies of weigh tickets, receipts, or invoices that specifically identify the project generating the material. Said documents must be from recyclers and/or disposal site operators that can legally accept the materials for the purpose of re-use, recycling, or disposal.
 4. Indicate project title, project number, progress payment number, name of the company completing the Contractor's Report and compiling backup documentation, the printed name, signature, and daytime phone number of the person completing the form, the beginning and ending dates of the period covered on the Contractor's Report, and the date that the Contractor's Report is completed.
- C. For LEED Projects, complete the LEED Construction and Demolition Waste Management Calculator in format provided under the most current version of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. Include a signed cover letter with calculation summary on company letterhead.
 1. Certify that the project has completed a waste management plan and diverted construction, demolition, and land clearing waste to uses other than landfill.
 2. Provide quantities of diverted materials and means of diversion in accordance with the results table in the LEED Construction and Demolition Waste Management Calculator.
 3. Indicate how and where waste was diverted.
 4. Indicate quantities of waste diverted in tons [or cubic yards].
 5. Letter will also include: Total quantity of diverted waste, total quantity of waste, and the percentage of waste diverted.
 6. Include name, organization, and role in project. Provide signature and date completed.
 7. Include legible copies of weigh tickets, receipts, or invoices that specifically identify the project generating the material. Said documents must be from recyclers and/or disposal site operators that can legally accept the materials for the purpose of re-use, recycling, or disposal.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SALVAGE, RE-USE, RECYCLING AND PROCEDURES

- A. Identify re-use, salvage, and recycling facilities.
- B. Develop and implement procedures to re-use, salvage, and recycle new construction and excavation materials, based on the Contract Documents, the Contractor's Construction Waste and Recycling Plan, estimated quantities of available materials, and availability of recycling facilities. Procedures may include on-site recycling, source separated recycling, and/or mixed debris recycling efforts.
 - 1. Identify materials that are feasible for salvage, determine requirements for site storage, and transportation of materials to a salvage facility.
 - 2. Source separate new construction, excavation and demolition materials including, but not limited to the following types:
 - a. Asphalt.
 - b. Concrete, concrete block, slump stone (decorative concrete block), and rocks.
 - c. Drywall.
 - d. Green materials (i.e. tree trimmings and land clearing debris).
 - e. Metal (ferrous and non-ferrous).
 - f. Miscellaneous construction debris.
 - g. Paper or cardboard.
 - h. Red clay brick.
 - i. Reuse or salvage materials
 - j. Soils.
 - k. Wire and cable.
 - l. Wood.
 - m. Other (describe)
 - 3. Miscellaneous Construction Debris: Develop and implement a program to transport loads of mixed (commingled) new construction materials that cannot be feasibly source separated to a mixed materials recycling facility.

3.2 DISPOSAL OPERATIONS AND WASTE HAULING

- A. Legally transport and dispose of materials that cannot be delivered to a source separated or mixed recycling facility to a transfer station or disposal facility that can legally accept the materials for the purpose of disposal.
- B. Use a permitted waste hauler or Contractor's trucking services and personnel. To confirm valid permitted status of waste haulers, contact the local solid waste authority.
- C. Become familiar with the conditions for acceptance of new construction, excavation and demolition materials at recycling facilities, and prior to delivering materials.

- D. Deliver to facilities that can legally accept new construction, excavation and demolition materials for purpose of re-use, recycling, composting, or disposal.
- E. Do not burn, bury or otherwise dispose of solid waste on the project job-site.

3.3 RE-USE AND DONATION OPTIONS

Implement a re-use program to the greatest extent feasible. Options may include:

California Materials Exchange (CAL-MAX) is a free program sponsored by CalRecycle and is designed to help connect businesses, organizations, manufacturers, schools, and individuals with the most effective online resources for exchanging materials. Go to <http://www.calrecycle.ca.gov/CalMAX/>. Public Surplus is a government agency surplus auction system used by many universities. Go to <https://www.publicsurplus.com> for more information.

3.4 REVENUE

Revenues or other savings obtained from recycled, re-used, or salvaged materials shall accrue to Contractor unless otherwise noted in the Contract Documents.

END OF SECTION 01 74 19

SECTION 01 74 19A
CONTRACTOR'S CONSTRUCTION WASTE AND RECYCLING PLAN

(Submit After Award of Contract and Prior to Start of Work)

Project Title:		
Contract or Work Order No.:		
Contractor's Name:		
Street Address:		
City:	State:	Zip:
Phone: ()	Fax: ()	
E-Mail Address:		
Prepared by: (Print Name)		

Date Submitted:		
Project Period:	From:	TO:

Reuse, Recycling or Disposal Processes To Be Used

Describe the types of recycling processes or disposal activities that will be used for material generated in the project. Indicate the type of process or activity by number, types of materials, and estimated quantities that will be recycled or disposed in the sections below:

- 01 - Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick)
- 02 - Salvaging building materials or salvage items at an off site salvage or re-use center (i.e. lighting, fixtures)
- 03 - Recycling source separated materials on site (i.e. crushing asphalt/concrete for reuse or grinding for mulch)
- 04 - Recycling source separated materials at an off site recycling center (i.e. scrap metal or green matls)
- 05 - Recycling commingled loads of C&D matls at an off site mixed debris recycling center or transfer station
- 06 - Recycling material as Alternative Daily Cover at landfills
- 07 - Delivery of soils or mixed inerts to an inert landfill for disposal (inert fill).
- 08 - Disposal at a landfill or transfer station.
- 09 - Other (please describe) _____

Types of Material To Be Generated

Use these codes to indicate the types of material that will be generated on the project

- | | | | | |
|---|---------------------|------------------|--------------------------|-----------------|
| A = Asphalt | C = Concrete | M = Metals | I = Mixed Inert | G = Green Matls |
| D = Drywall | P/C=Paper/Cardboard | W/C = Wire/Cable | S= Soils (Non Hazardous) | |
| M/C = Miscellaneous Construction Debris | R = Reuse/Salvage | W = Wood | O = Other (describe) | |

Facilities Used: Provide Name of Facility and Location (City)

Total Truck Loads: Provide Number of Trucks Hauled from Site During Reporting Period

Total Quantities: If scales are available at sites, report in tons. If not, quantify by cubic yards. For salvage/reuse items, quantify by estimated weight (or units).

SECTION I - RE-USED/RECYCLED MATERIALS

Include all recycling activities for source separated or mixed material recycling centers where recycling will occur.

Type of Material	Type of Activity	Facility to be Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) M	04	ABC Metals, Los Angeles	24	355		
a. Total Diversion			-	-	-	-

SECTION 01 74 19A
 CONTRACTOR'S CONSTRUCTION WASTE AND RECYCLING PLAN
 Continued

SECTION II - DISPOSED MATERIALS						
<i>Include all disposal activities for landfills, transfer stations, or inert landfills where no recycling will occur.</i>						
Type of Material	Type of Activity	Facility to be Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) D	08	DEF Landfill, Los Angeles	2	35		
b. Total Disposal				-	-	-

SECTION III - TOTAL MATERIALS GENERATED						
<i>This section calculates the total materials to be generated during the project period (Reuse/Recycle + Disposal = Generation)</i>						
				Tons	Cubic YD	Other Wt.
a. Total Reused/Recycled				-	-	-
b. Total Disposed				-	-	-
c. Total Generated				-	-	-

SECTION IV - CONTRACTOR'S LANDFILL DIVERSION RATE CALCULATION						
<i>Add totals from Section I + Section II</i>						
			Tons	Cubic Yards	Other Wt.	
a. Materials Re-Used and Recycled			-			
b. Materials Disposed			-			
c. Total Materials Generated (a. + b. = c.)			-	-	-	
d. Landfill Diversion Rate (Tons Only)*			#DIV/0!			

* Use tons only to calculate recycling percentages: $Tons\ Reused/Recycled/Tons\ Generated = \% \text{ Recycled}$

Contractor's Comments (Provide any additional information pertinent to planned reuse, recycling, or disposal activities):

Notes:

1. Suggested Conversion Factors: From Cubic Yards to Tons (Use when scales are not available)

Asphalt: .61 (ex. 1000 CY Asphalt = 610 tons. Applies to broken chunks of asphalt)

Concrete: .93 (ex. 1000 CY Concrete = 930 tons. Applies to broken chunks of concrete)

Ferrous Metals: .22 (ex. 1000 CY Ferrous Metal = 220 tons)

Non-Ferrous Metals: .10 (ex. 1000 CY Non-Ferrous Metals = 100 tons)

Drywall Scrap: .20

Wood Scrap: .16

SECTION 01 74 19B
CONTRACTOR'S REUSE, RECYCLING, AND DISPOSAL REPORT

(Submit With Each Progress Payment)

Project Title:		
Contract or Work Order No.:		
Contractor's Name:		
Street Address:		
City:	State:	Zip:
Phone: ()	Fax: ()	
E-Mail Address:		
Prepared by: (Print Name)		

Date Submitted:		
Period Covered:	From:	To:

Reuse, Recycling or Disposal Processes Used

Describe the types of recycling processes or disposal activities used for material generated in the project. Indicate the type of process or activity by number, types of materials, and quantities that were recycled or disposed in the sections below:

- 01 - Reuse of building materials or salvage items on site (i.e. crushed base or red clay brick)
- 02 - Salvaging building materials or salvage items at an off site salvage or re-use center (i.e. lighting, fixtures)
- 03 - Recycling source separated materials on site (i.e. crushing asphalt/concrete for reuse or grinding for mulch)
- 04 - Recycling source separated materials at an off site recycling center (i.e. scrap metal or green mats)
- 05 - Recycling commingled loads of C&D mats at an off site mixed debris recycling center or transfer station
- 06 - Recycling material as Alternative Daily Cover at landfills
- 07 - Delivery of soils or mixed inerts to an inert landfill for disposal (inert fill).
- 08 - Disposal at a landfill or transfer station.
- 09 - Other (please describe) _____

Types of Material Generated

Use these codes to indicate the types of material that were generated on the project

- | | | | | |
|---|---------------------|------------------|--------------------------|----------------|
| A = Asphalt | C = Concrete | M = Metals | I = Mixed Inert | G = Green Mats |
| D = Drywall | P/C=Paper/Cardboard | W/C = Wire/Cable | S= Soils (Non Hazardous) | |
| M/C = Miscellaneous Construction Debris | R = Reuse/Salvage | W = Wood | O = Other (describe) | |

Facilities Used: Provide Name of Facility and Location (City)

Total Truck Loads: Provide Number of Trucks Hauled from Site During Reporting Period

Total Quantities: If scales are available at sites, report in tons. If not, quantify by cubic yards. For salvage/reuse items, quantify by estimated weight (or units).

SECTION I - RE-USED/RECYCLED MATERIALS

Include all recycling activities for source separated or mixed material recycling centers where recycling occurred.

Type of Material	Type of Activity	Facilities Used, Location	Total Truck Loads	Total Quantities		
				Tons	Cubic YD	Other Wt.
(ex.) M	04	ABC Metals, Los Angeles	24	355		
a. Total Diversion			-	-	-	-

SECTION 01 75 00

STARTING AND ADJUSTING PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Starting systems.
- B. Demonstration and instructions.
- C. Testing, adjusting, and balancing.

1.3 RELATED SECTIONS

- A. Section 01 45 00 - Quality Control: Manufacturers field reports.
- B. Section 01 78 03 - Operation and Maintenance Data: System operation and maintenance data and extra materials.
- C. Section 01 79 00 – Demonstration and Testing

1.4 STARTING SYSTEMS

- A. Contractor shall coordinate schedule for start-up of various equipment and systems.
- B. Contractor shall notify University's Representative, Architect and Project Inspector in writing at least seven calendar days prior to start-up of each item.
- C. Contractor shall verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Contractor shall verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Contractor shall verify that wiring and support components for equipment are complete and tested.
- F. Contractor shall execute start-up under supervision of applicable manufacturer's representative and/or Contractor's personnel in accordance with manufacturer's instructions.
- G. When specified in individual specification Sections, Contractor shall require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Contractor shall submit a written report in accordance with Section 01 33 00 - Submittals Procedures that equipment or system has been properly installed and is functioning correctly.

1.5 DEMONSTRATION AND INSTRUCTIONS

- A. Contractor shall demonstrate operation and maintenance of Products to University's personnel at least two weeks prior to date of Contract Completion review.
- B. Contractor shall demonstrate Project equipment and instruct in a classroom environment located at the University. The instruction shall be done by a qualified manufacturers' representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, Contractor shall perform demonstration for other season within six months of completion or, if possible, artificially create a load in the building.
- D. Contractor shall utilize operation and maintenance manuals as basis for instruction. Contractor shall review contents of manual with University's personnel in detail to explain all aspects of operation and maintenance.
- E. Contractor shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled agreed time and at equipment/designated location.
- F. Contractor shall prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections. If no time is specified in individual sections, Contractor shall include in his/her bid sum a reasonable sum to perform instruction to the satisfaction of the University.

1.6 TESTING, ADJUSTING, AND BALANCING

- A. Testing Agency: Contractor shall appoint, employ, and pay for services of an independent firm to perform testing, adjusting and balancing.
- B. Reports will be submitted by the independent firm to University's Representative, Architect and Project Inspector indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.
- C. University reserves the right to hire its own independent testing and balancing company to check the work and the report submitted by the Contractor's testing and balancing firm.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 77 00

CONTRACT CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Contract closeout procedures, including Contract Closeout meetings, correction ("punch") lists, submittals and final payment procedures.

1.3 RELATED SECTIONS

- A. Section 01 33 00 - Submittals Procedures: General requirements for submittals.
- B. Section 01 74 00 - Cleaning Requirements: Progress cleaning and cleaning as part of Contract closeout.
- C. Section 01 78 33 - Warranties and Bonds: Documents to be submitted as part of Contract closeout.
- D. Section 01 78 39 – Project Record Documents: Project record drawings and specifications to be submitted as part of Contract closeout; operation and maintenance data to be submitted as part of Contract closeout.

1.4 FINAL COMPLETION ACTIONS

- A. Contractor Responsibility: Contractor shall be solely responsible for the timely completion of all required Contract closeout items except for filing of Notice of Completion by the Trustees.
- B. Warranties, Bonds and Certificates: Contractor shall submit specific warranties, guarantees, workmanship bonds, maintenance agreements, final certifications and similar documents.
- C. Locks and Keys: Contractor shall change temporary lock cylinders over to permanent keying and transmit keys to Trustees, unless otherwise directed or specified.
- D. Tests and Instructions: Contractor shall complete start-up testing of systems, and instruction of the University's personnel. Contractor shall remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

1.5 CONTRACT COMPLETION REVIEW

- A. Contractor's Notification for Contract Completion Review Meeting: When the Contractor determines that the Work is complete in accordance with Contract Documents, the Contractor shall submit to University's Representative and Architect written certification that the Contract Documents have been reviewed, the Work has been inspected by the Contractor and by authorities having jurisdiction, and the facility is ready for the Contract Completion review.
- B. Contract Completion Review Meeting: University's Representative and, as authorized by the Trustees, Architect and Architect's and Trustees' representatives and consultants, as appropriate, will attend a meeting at the Project site to review Contract closeout procedures and to review the items to be completed and corrected Punch List to make the Work ready for acceptance by the Trustees. This meeting shall be typically scheduled four to six weeks prior to scheduled completion date.

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- C. **Punch List:** Architect shall prepare subsequent to the Contract completion review meeting, a typewritten, comprehensive list of items to be completed and corrected (Punch List) to make the Work ready for acceptance by the Trustees.
1. The Punch List shall include all items to be completed or corrected prior to the Contractor's application for final payment.
 2. The Punch List shall identify items by location (room number or name) and consecutive number. For example, 307-5 would identify item 5 in Room 307, Roof-4 would identify item 4 on Roof.
 3. Architect and Architect's consultants shall prepare separate lists according to categories used for Drawings. For example, provide lists for Architectural, Structural, Mechanical (HVAC), Plumbing, Fire Protection (sprinkler) system, Electrical and Equipment. But all lists shall be compiled by the Architect into the all inclusive Master Punch List.
 4. Items to be considered shall include but not be limited to:
 - Corrections to construction.
 - Operation and maintenance data (manuals).
 - HVAC testing and balancing reports.
 - Spare parts and extra materials.
 - Keys, permanent keying and lock cylinders.
 - Warranties and guaranties.
 - Project record Drawings and Specifications.
 - Project record construction schedule.
 - State Fire Marshal Inspection.
 - Elevator Inspection (if applicable).
 - Other regulatory inspections.
 - Removal of construction facilities and temporary controls.
 - Final cleaning and pest control.
 - Landscape maintenance.
 - Commissioning/equipment startup.
 - Demonstration and training.
 - Acceptance.
 - Notice of Completion, filing by Trustees.
 - Final application for payment.
 - Occupancy by University.
 - Other closeout items specified.
- D. **Contract Completion Meeting:** On a date mutually agreed by University's Representative, Architect and Contractor, a meeting shall be conducted at the Project site to determine whether the Work is satisfactory and has achieved Contract Completion.
1. Contractor shall provide a minimum seven calendar days written notice to the University's Representative and Architect for requested date of Contract Completion meeting.
 2. Architect and the Architect's consultants will attend the Contract Completion meeting.
 3. In addition to conducting a walk-through of the facility and reviewing the Punch List, the purpose of the meeting shall include submission of warranties, guarantees and bonds to University, submission of operation and maintenance data (manuals), provision of specified extra materials to University, and submission of other Contract closeout documents and materials as required and if not already submitted.
 4. Architect and Architect's consultants, as appropriate, will conduct a walk-through of the facility with the University's Representative and Contractor to review the Punch List.
 5. Architect shall update the Punch List and record additional items as may identified during the walk-through, including notations of corrective actions to be taken.
 6. Architect shall retype the Punch List and distribute it within five calendar days to those attending the meeting.
- E. **Uncorrected Work:** Refer to requirements specified in Section 01 45 00 - Quality Control regarding Contract adjustments for non-conforming Work.
- F. **Clearing and Cleaning:** Prior to the Contract Completion review, Contractor shall conduct a thorough cleaning and clearing of the Project area, including removal of construction facilities and temporary controls. Refer to Section 01 74 00 - Cleaning Requirements.

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- G. Inspection and Testing: Prior to the Contract Completion review, Contractor shall complete inspection and testing required for the Work, including securing of approvals by authorities having jurisdiction.
 - 1. Complete all inspections, tests, balancing, sterilization and cleaning of plumbing and HVAC systems.
 - 2. Complete inspections and tests of electrical power and signal systems.
 - 3. Complete inspections and tests of conveying (elevator) systems.
- H. Notice of Completion: University will record the Notice of Completion with County Recorder, when the Project is complete in all respects.

1.6 FINAL COMPLETION SUBMITTALS

- A. Final Completion Submittals: Prior to application for Final Payment, Contractor shall submit the following.
- B. Agency Document Submittals: Contractor shall submit to University all documents required by authorities having jurisdiction, including serving utilities and other agencies. Contractor shall submit original versions of all permit cards, with final sign-off by inspectors. Submit all certifications of inspections and tests.
- C. Final Specifications Submittals: Contractor shall submit to University all documents and products required by Specifications to be submitted, including the following:
 - 1. Project record drawings and specifications.
 - 2. Operating and maintenance data.
 - 3. Guarantees, warranties and bonds.
 - 4. Keys and keying schedule.
 - 5. Spare parts and extra stock.
 - 6. Test reports and certificates of compliance.
- D. Certificates of Compliance and Test Report Submittals: Contractor shall submit to University's Representative certificates and reports as specified and as required by authorities having jurisdiction, including but not limited to the following:
 - 1. Sterilization of water systems.
 - 2. Sanitary sewer system tests.
 - 3. Gas system tests.
 - 4. Lighting, power and signal system tests.
 - 5. Ventilation equipment and air balance tests.
 - 6. Fire sprinkler system tests.
 - 7. Roofing inspections and tests.
- E. Subcontractors List: Contractor shall submit two copies of updated Subcontractor and Materials Supplier List to University's Representative and one copy to Architect.
- F. Warranty Documents: Contractor shall prepare and submit to University all warranties and bonds as specified in Section 01 78 33 - Product Warranties and Bonds.
- G. Service Agreements and Service Contracts: Contractor shall submit to University's Representative.
- H. Contractor shall submit final electrical and water meter readings. Refer to section 01 51 00 – Temporary Utilities.

1.7 FINAL PAYMENT

- A. Final Payment: After completion of all items listed for completion and correction and after submission of all documents and products and after final cleaning, Contractor shall submit final Application for Payment, identifying total adjusted Contract Sum, previous payments and sum remaining due. Payment will not be made until the following are accomplished:
 - 1. All Project Record Documents have been received and accepted by the Architect and the University.
 - 2. All extra materials and maintenance stock have been transferred and accepted by University.
 - 3. All warranty documents and operation, maintenance data, service agreements, maintenance contracts and salvage materials have been received and accepted by University's Representative.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

PROJECT _____

PROJECT NO. _____

CONTRACTOR _____

CONTRACT NO. _____

ARCHITECT _____

DATE _____

PROJECT CLOSEOUT CHECKLIST

Project Manager/Inspector of Record will complete this form and transmit it to the Construction Administrator with his/her recommendation to certify occupancy and completion, and release retention.

Item	Verification	
	Date Completed	Initials
Required for Occupancy		
1.	Final Inspection Punch List to GC	
2.	State Fire Marshal Inspection	
3.	Occupancy Change Order	
4.	Certification of Occupancy (Form 702.02-OCR) (certification by DBO)	
Required for Notice of Completion		
4.	HVAC Balance Report	
5.	Keys/Keying	
6.	Training	
7.	Final Inspection Punch List Completed	
8.	Special Inspection Final Report	
9.	Elevator Inspection	
10.	Other Regulatory Inspection	
11.	Removal of Temporary Facilities	
12.	Final Cleaning	
13.	Commissioning	
14.	Cessation of Onsite Labor	
15.	Other 01 77 00 Requirements (Specify)	
16.	Certification of Completion (Form 702.02-OCR) (certification by A/E, PM, IOR, and DBO)	
Required for Release of Retention		
17.	Spare Parts/Materials	
18.	Warranties	
19.	As Builts	
20.	As-Built Schedule	
21.	Landscape Maintenance Period Ends	
22.	O & M Manuals	
23.	Claims Resolved <i>or</i> Funds Held	
24.	Stop Notices Closed <i>or</i> Funds Held	
25.	Release from Labor Compliance Manager	
26.	Release of Retention (Form 702.02-OCR) (by PM and University Construction Administrator)	

The undersigned certifies that all of the above-listed items are complete.

(Name), Construction Administrator

Date

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SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Format and content of operation and maintenance manuals.
 - 1. Data requirements for materials and finishes.
 - 2. Data requirements for equipment and operating systems.
- B. Instruction of University's personnel.
- C. Submission of operation and maintenance manuals.

1.3 RELATED SECTIONS

- A. Section 01 31 00 - Coordination: Coordination documents and models prepared for performance of the Work, to be incorporated into operation and maintenance data submitted to University's Representative at Contract closeout.
- B. Section 01 45 00 - Quality Control: Manufacturer's instructions; test and balance reports.
- C. Section 01 61 00 - Basic Product Requirements: Systems demonstration.
- D. Section 01 77 00 - Contract Closeout Procedures: Contract closeout procedures.
- E. Section 01 78 33 - Product Warranties and Bonds: Requirements for warranties and bonds.
- F. Section 01 78 39 - Project Record Documents: Submission of Project record documents.
- E. Product Specifications Sections in Divisions 2 through 49: Specific requirements for operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Contractor shall ensure that preparation of data shall be done by persons:
 - 1. Trained and experienced in maintenance and operation of the described products.
 - 2. Familiar with requirements of this Section.
 - 3. Skilled in technical writing to the extent required to communicate essential data.
 - 4. Skilled as drafters competent to prepare required drawings.

1.5 FORMAT AND CONTENT OF OPERATION AND MAINTENANCE MANUALS

- A. Format for Operation and Maintenance Data Manuals: Contractor shall prepare data in the form of an instructional manual. Contractor shall comply with the general requirements specified below and comply with specific requirements for types of products in Articles following. See Article titled "SUBMISSION OF OPERATION AND MAINTENANCE MANUALS" for number of copies of manuals.
- B. Operation and Maintenance Data Organization: Contractor shall organize operation and maintenance data in

- three-ring binders and organize the contents of each binder following the organization of the Contract Specifications. Contractor shall:
1. Organize the group of binders and the contents of individual binders in sequence according to the Section numbers and titles as listed in the Table of Contents of the Project Manual. Number the binders consecutively; coordinate with Paragraph below titled "Tables of Contents."
 2. Organize each binder with color-coded tabbed dividers for each distinct product and system, with typed inserts in tabs identifying the product or system.
 3. Organize the contents of each tabbed division according to the Article headings in PART 2 - PRODUCTS in each product Specification Section.
 - a. Within each tabbed division, organize the information according to major component parts of equipment and systems, as applicable, and to facilitate locating information.
 - b. Separate operation and maintenance data for each product under separate tabbed divisions, where feasible.
 - c. Within each tabbed division, include a cover sheet identifying the specific products and component parts included in the tabbed division.
 4. If the products of more than one Specification Section are included in the binder, provide separate, heavy cover stock dividers to separate information for each Section.
- C. Binders: Contractor shall use 8-1/2 x 11 inch, standard three-ring binders with heavy duty vinyl covers with hard cardboard backing, black color, with provision on binder spine for inserting identification card; Maximum binder ring size shall be three inches. Contractor shall use multiple binders as necessary to avoid overfilling. When multiple binders are used, Contractor shall correlate data into related consistent groupings.
- D. Cover: Contractor shall identify each binder with typed or printed card inserted on binder spine, stating OPERATION AND MAINTENANCE DATA, the Project name and the general subject matter of the contents of the binder.
- E. Title Page: In each volume (binder) of operation and maintenance data, Contractor shall include a title page with the following:
 1. Name of the Project.
 2. Names, addresses and telephone numbers of the responsible design professionals (Architect and Architect's or University's consultant, as applicable).
 3. Name, address and telephone numbers of Contractor, including names of contact persons.
- F. Table of Contents: In each volume (binder) of operation and maintenance data, Contractor shall include a listing of the contents of the volume. In a separate, first binder, Contractor shall provide a master Table of Contents of operation and maintenance data, identifying the product and systems, the applicable Specification Section number and title, and the operation and maintenance data binder number.
- G. Schedule of Products and Systems: In the first volume of the set of operation and maintenance data, Contractor shall include a schedule of products and systems, indexed to the Table of Contents of the volumes (binders) and cross-referenced to the Contract Drawings and Specifications.
- H. Operation and Maintenance Data: In each tabbed division of operation and maintenance data for each product or system, Contractor shall provide the following:
 1. On a cover page for each tabbed division, Contractor shall provide the following:
 - a. Identify by name, address and telephone number, the manufacturer, supplier and installer. Include names of contact persons, if known.
 - b. Identify by name, address and telephone number, local sources of supplies, replacement parts and factory-authorized service.
 2. Within each tabbed division, Contractor shall include complete operation and maintenance data as published by the product manufacturer where feasible. Otherwise, present all data neatly typewritten on 20 pound, correspondence quality bond paper. Contractor shall strike-through information on printed literature where not applicable.
 3. Contractor shall supplement the manufacturer's printed data with neatly typewritten text and professionally drafted diagrams as necessary to suit the particular installation for the Project and to fully

explain operation and maintenance procedures. Contractor shall provide logical sequence of instructions for each procedure.

- I. Drawings: Contractor shall supplement operation and maintenance data to illustrate configurations and relationships of component parts of equipment and systems, and to show control and flow diagrams, as applicable.
 - 1. Contractor shall not use Project Record Documents as maintenance drawings.
 - 2. Contractor shall neatly fold drawings to size of text pages and provide reinforced, punched binding edge. Add binding strip as necessary to avoid punching through drawing content.
- J. Additional Data: As specified in individual product Specification Sections.
- K. Warranty and Guaranty: Contractor shall include copy of each warranty, and any guaranty, bond and service contract issued. Contractor shall provide information sheet identifying:
 - 1. Proper procedures in event of failure.
 - 2. Instances that might affect validity of warranties or bonds.
- L. Material Safety Data Sheet (MSDS): For products requiring MSDS, according to CCR Title 8 and the University Contractor Safety Handbook, Contractor shall include copy of each applicable Material Safety Data Sheet (MSDS) for products delivered to the site and incorporated into the completed construction.

1.6 DATA REQUIREMENTS FOR MATERIALS AND FINISHES

- A. Data for Building Products, Applied Materials and Finishes: Contractor shall include product data, with catalog number, size, composition, and color and texture designations. Contractor shall provide information for re-ordering custom manufactured Products.
- B. Instructions for Care and Maintenance: Contractor shall include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Data for Moisture Protection and Weather-Exposed Products: Contractor shall include product data listing applicable reference standards, chemical composition, and details of installation. Contractor shall provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements: As specified in individual product Specification Sections.

1.7 DATA REQUIREMENTS FOR EQUIPMENT AND OPERATING SYSTEMS

- A. Data for Equipment and Operating Systems: Contractor shall include description of each unit or system, and component parts.
 - 1. Include manufacturer's printed operation and maintenance instructions.
 - 2. Identify function, normal operating characteristics and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Include sequence of operation by controls manufacturer, as applicable.
 - 5. Provide diagrams by controls manufacturer for control systems, as applicable and as installed.
- B. Piping Data: Contractor shall provide Contractor's coordination drawings, with piping diagrams as installed. Contractor shall provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Contractor shall color code diagrams as necessary for clarity.
- C. Reports: Contractor shall include test and balancing reports, as applicable and as specified in individual product Specification Sections.
- D. Panelboard Circuit Directories: Contractor shall provide electrical service characteristics, controls and communications.

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- E. Wiring Diagrams: Contractor shall include diagrams of wiring as installed, with color coding as necessary for clarity.
- F. Operating Procedures: Contractor shall include:
 - 1. Start-up, break-in, and routine normal operating instructions and sequences.
 - 2. Regulation, control, stopping, shut-down, and emergency instructions.
 - 3. Summer and winter operating instructions.
 - 4. Special operating instructions.
- G. Maintenance Requirements: Contractor shall include:
 - 1. Routine maintenance procedures and guide for trouble-shooting.
 - 2. Disassembly, repair, and reassembly instructions.
 - 3. Alignment, adjusting, balancing, and checking instructions.
- H. Servicing and Lubrication: Contractor shall provide servicing and lubrication schedule, and list of lubricants required.
- I. Parts Data: Contractor shall provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams as necessary for service and maintenance. Contractor shall:
 - 1. Include complete nomenclature and catalog numbers for consumable and replacement parts.
 - 2. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in stock by the University or operator.
- J. Software: Contractor shall provide all programming codes, access codes and other data necessary for operation, maintenance, future functioning and modifications of microprocessor-controlled products, independent of Original Equipment Manufacturer (OEM).
- K. Additional Requirements: As specified in individual product Specification Sections.

1.8 DATA REQUIREMENTS FOR ELECTRIC AND ELECTRONIC SYSTEMS

- A. Data Requirements for Electrical and Electronic Systems: Contractor shall provide description of each system and component parts, including:
 - 1. Function, normal operating characteristics and limiting conditions.
 - 2. Performance curves, engineering data and tests.
 - 3. Complete nomenclature and commercial number of replaceable parts.
- B. Circuit Directories of Panel Boards: Contractor shall include:
 - 1. Electrical service.
 - 2. Controls.
 - 3. Communications.
- C. Wiring Diagrams: As-installed, color-coded wiring diagrams.
- D. Operating procedures: Contractor shall provide:
 - 1. Routine and normal operating instructions.
 - 2. Sequences required.
 - 3. Special operating instructions.
- E. Maintenance procedures: Contractor shall provide:
 - 1. Routine operations.
 - 2. Guide to "trouble-shooting."
 - 3. Disassembly, repair and reassembly.
 - 4. Adjustment and checking.
- F. Contractor shall provide Manufacturer's printed operating and maintenance instructions.

- G. Contractor shall provide list of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
- H. Contractor shall prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
- I. Additional requirements for operating and maintenance data: Respective sections of specifications.

1.9 INSTRUCTION OF UNIVERSITY'S PERSONNEL

- A. Instruction of University's Personnel: Prior to Contract Completion review, Contractor shall complete instruction of University's designated personnel in the operation, adjustment and routine cleaning, service and maintenance of products, equipment, and systems. Contractor shall schedule indoctrination and training sessions at times acceptable to University. Contractor shall coordinate with requirements specified in Section 01 79 00 - Demonstration and Training.
- B. Basis for Instruction: Contractor shall use operation and maintenance manuals as basis for instruction. Contractor shall review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. Instructional Material: Contractor shall prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.10 SUBMISSION OF OPERATION AND MAINTENANCE MANUALS

- A. Submittal: Contractor shall submit six copies to Architect for review and approval prior to submission of final Application for Payment.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

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SECTION 01 78 29

SURVEY AND LAYOUT DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Administrative requirements for survey and layout data submittals.

1.3 RELATED SECTIONS

- A. Section 01 45 00 - Quality Control: Test and inspection reports.
- B. Section 01 72 00 - Preparation Requirements: Layout of the Work and other engineering services required for accomplishing the Work.
- C. Section 01 77 00 - Contract Closeout Procedures: Submittals for occupancy, Acceptance and Final Payment.

1.4 LAYOUT OF THE WORK

- A. Responsibility for Layout of the Work: Contractor shall be solely responsible for complete, timely and accurate layout of the Work including, but not necessarily limited to, horizontal and vertical control and dimensional coordination as necessary to construct the Work in accordance with the Contract Documents. Contractor shall:
 - 1. Employ a Land Surveyor or a Civil Engineer, registered in the State of California, to perform survey work.
 - 2. Employ a Professional Engineer, of the discipline required for the specific service on the Project, and licensed in the State of California where required in the specifications in Divisions 2 through 49.
- B. Survey Reference Points: Existing basic horizontal and vertical control points are shown on the Contract Documents, or location of control points will be furnished by the University Representative. Contractor shall use the University Record of Survey, provided by the University Representative, as the Basis of Bearings for survey horizontal control, and shall tie at least one Project site control point to a point on the University Record of Survey. Contractor shall:
 - 1. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction.
 - 2. Make no changes or relocations without prior written notice to Architect.
 - 3. Report to University Representative and Architect when any reference point is lost or destroyed.
 - 4. Require a surveyor to replace project control points which may be lost or destroyed. Establish replacements based on original survey control.

1.5 LAYOUT RECORD SUBMITTALS

- A. Land Surveyor: Contractor shall submit name, address and telephone number of land surveyor before starting survey work.
- B. Survey Logs: On request, Contractor shall submit copies of field documents verifying accuracy of survey Work.

- C. Submittal: Contractor shall submit a copy of registered site drawing and certificate signed by the land surveyor that the elevations and locations of the Work are in conformance with Contract Documents.

1.6 SURVEY RECORD DOCUMENTS

- A. Survey Record Documents: Contractor shall maintain a complete and accurate log of control and survey work as Work progresses. Upon completion of foundation walls and major site improvements, Contractor shall prepare a certified survey illustrating dimensions, locations, angles and elevations of new construction and site work. Contractor shall submit survey record documents as specified in Section 01 77 00 - Contract Closeout Procedures.
- B. Locations provided on the certified survey shall be coordinated with the control points tied to the University Record of Survey as per Section 1.4B.
- C. For each new Project utility or improvement which is not to be owned and maintained by the University, Contractor shall provide a legal description and plot, stamped and signed by a properly licensed surveyor or Civil Engineer, and which will use the University Record of Survey as the Basis of Bearings and will provide a Point of Commencement shown on said Record of Survey.

1.7 CONTRACTOR'S REVIEW

- A. Scope of Contractor's Review: Survey and layout data shall be reviewed by Contractor prior to submission for University's review or filing. Contractor shall sign each submittal copy certifying that:
 - 1. Field measurements have been determined and verified.
 - 2. Field construction criteria have been verified.
 - 3. Conformance with Drawings and Specifications requirements is confirmed.
- B. Contractor's Review Action: Contractor shall indicate clearly on survey and layout data whether the dimensions and coordinates are in compliance with Contract requirements. Contractor shall note clearly and sign each submittal certifying that reported data "Conforms" or "Does Not Conform".
- C. Changes and Deviations: Contractor shall identify all deviations from requirements of Drawings and Specifications. Changes in the Work shall not be authorized by submittals review actions. No review action, implicit or explicit, shall be interpreted to authorized changes in the Work. Changes shall only be authorized by separate written Change Order or Field Instruction, in accordance with the Contract General Conditions.

1.8 REVIEWS BY UNIVERSITY'S REPRESENTATIVE AND ARCHITECT

- A. Reviews by University's Representative and Architect, General: Reviews of survey and layout data by University's Representative and Architect, or other responsible design professional, shall be only for general conformance with the design concept and requirements based on the information presented. Neither Architect nor other responsible design professional shall verify submitted survey and layout data.
- B. Contract Requirements: Reviews by University's Representative, Architect or other responsible design professional shall not relieve the Contractor from compliance with requirements of the Drawings and Specifications. Changes shall only be authorized by separate written Change Order or Field Instruction, in accordance with the Contract General Conditions.

PART 2 - PRODUCTS

Not applicable to this Section.

PART 3 - EXECUTION

Not applicable to this Section.

END OF SECTION

SECTION 01 78 33

PRODUCT WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. General administrative and procedural requirements for preparation and submission of warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special Project warranties.
 - 1. Refer to the Contract General Conditions for terms of Contractor's special warranty of workmanship and materials.
 - 2. Certifications and other commitments and agreements for continuing services to University are specified elsewhere in the Contract Documents.

1.3 RELATED DOCUMENTS AND SECTIONS

- A. Section 01 33 00 - Submittals Procedures: General administrative requirements for submittals, applicable to warranties and bonds.
- B. Section 01 77 00 - Contract Closeout Procedures: General requirements for closeout of the Contract.
- C. Section 01 78 23 - Operation and Maintenance Data: Operating and maintenance data binders, to include copies of warranties and bonds.
- D. Product Specifications Sections in Divisions 2 through 49: Special Project warranty requirements for specific products or elements of the Work; commitments and agreements for continuing services to University.

1.4 DEFINITIONS

- A. Warranty: Assurance to University by Contractor, installer, supplier, manufacturer or other party responsible as warrantor, for the quantity, quality, performance and other representations of a product, system service of the Work, in whole or in part, for the duration of the specified period of time. The University's standard warranty form shall be used for all warranties under this Contract unless otherwise agreed to in writing by the University Representative.
- B. Guaranty: Assurance to University by Contractor or product manufacturer or other specified party, as guarantor, that the specified warranty will be fulfilled by the guarantor in the event of default by the warrantor.
- C. Standard Product Warranty: Preprinted, written warranty published by product manufacturer for particular products and specifically endorsed by the manufacturer to the University.
- D. Special Project Warranty: Written warranty required by or incorporated into Contract Documents, to extend time limits provided by standard warranty or to provide greater rights for University.
- E. Guaranty Period: As defined in the Contract General Conditions, guaranty period shall be synonymous with "warranty period", "correction period" and similar terms used in the Contract Specifications. Warranty period shall be one year from the date of Project Completion unless otherwise agreed to in writing by the University Representative.

1.5 WARRANTIES AND GUARANTIES

- A. Warranties and Guaranties, General: Contractor shall provide all warranties and guaranties with University named as beneficiary. For equipment and products, or components thereof, bearing a manufacturer's warranty or guaranty that extends for a period of time beyond the Contractor's warranty and guaranty, Contractor shall so state in the warranty or guaranty.
- B. Provisions for Special Warranties: Contractor shall refer to Contract General Conditions for terms of the Contractor's special warranty of workmanship and materials.
- C. General Warranty and Guaranty Requirements: Warranty shall be an agreement to repair or replace, without cost and undue hardship to University, Work performed under the Contract which is found to be defective during the guaranty period (warranty or guaranty) period. Repairs and replacements due to improper maintenance or operation, or due to normal wear, usage and weathering are excluded from warranty requirements unless otherwise specified.
- D. Specific Warranty and Guaranty Requirements: Specific requirements are included in product Specifications Sections of Divisions 2 through 49, including content and limitations.
- E. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties and guaranties shall not relieve Contractor of responsibility for warranty and guaranty requirements for the Work that incorporates such products, nor shall they relieve suppliers, manufacturers, and installers required to countersign special warranties with Contractor.
- F. Related Damages and Losses: When correcting warranted Work that has been found defective, Contractor shall remove and replace other Work that has been damaged as a result of such defect or that must be removed and replaced to provide access for correction of warranted Work.
- G. Reinstatement of Warranty: When Work covered by a warranty has been found defective and has been corrected by replacement or rebuilding, Contractor shall reinstate the warranty by written endorsement.
- H. Replacement Cost: Upon determination that Work covered by a warranty has been found to be defective, Contractor shall replace or reconstruct the Work to a condition acceptable to University's Representative, complying with applicable requirements of the Contract Documents. Contractor shall be responsible for all costs for replacing or reconstructing defective Work regardless of whether University has benefited from use of the Work through a portion of its anticipated useful service life.
- I. University's Recourse: Written warranties made to University shall be in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under law, nor shall warranty periods be interpreted as limitations on time in which University can enforce such other duties, obligations, rights, or remedies.
 - 1. Rejection of Warranties: University reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- J. Warranty as Condition of Acceptance: University reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment shall be required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.6 PREPARATION OF WARRANTY AND BOND SUBMITTALS

- A. Project Warranty and Guaranty Forms: Forms for Project warranties and guaranties are included in the Contract Documents. Contractor shall submit the warranty package submittal to the Architect, with a copy to the University Representative, for review and approval. Contractor shall:
 - 1. Refer to product Specifications Sections of Divisions 2 through 49 for specific content requirements, and

- particular requirements for submittal of special warranties.
2. Prepare standard warranties and guaranties, excepting manufacturers' standard printed warranties and guaranties, on Contractor's, subcontractor's, material suppliers, or manufacturer's own letterhead, addressed to University as directed by University's Representative.
 3. Warranty and guaranty letters shall be signed by all responsible parties and by Contractor in every case, with modifications only as approved in advance by University's Representative to suit the conditions pertaining to the warranty or guaranty.
- B. **Manufacturer's Guaranty Form:** Manufacturer's guaranty form may be used instead of special Project form included in the Contract Documents, if agreed to in writing by the University's Representative. Manufacturer's guaranty form shall contain appropriate terms and identification, ready for execution by the required parties.
1. If proposed terms and conditions restrict guaranty coverage or require actions by University beyond those specified, Contractor shall submit draft of guaranty to the Architect and the University's Representative for review and approval before performance of the Work.
 2. In other cases, Contractor shall submit draft of guaranty to the Architect and the University's Representative for approval prior to final execution of guaranty.
- C. **Signatures:** Signatures shall be by person authorized to sign warranties, guaranties and bonds on behalf of entity providing such warranty, guaranty or bond.
- D. **Co-Signature:** All installer's warranties and bonds shall be co-signed by Contractor. Manufacturer's guaranties will not require co-signature.

1.7 FORM OF WARRANTY AND BOND SUBMITTALS

- A. **Form of Warranty and Bond Submittals:** Prior to completion, Contractor shall collect and assemble all written warranties and guaranties into binders and deliver binders to the Architect, with a copy to the University Representative, for final review and acceptance. Contractor shall:
1. Prior to submission, verify that documents are in proper form and contain all required information and are properly signed by Contractor, subcontractor, supplier and manufacturer, as applicable.
 2. Organize warranty and guaranty documents into an orderly sequence based on the Table of Contents of the Project Manual.
 3. Include Table of Contents for binder, neatly typed, following order and section numbers and titles as used in the Project Manual.
 4. Bind warranties, guaranties and bonds in heavy-duty, commercial quality, durable three-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, with clear front and spine to receive inserts, and sized to receive 8-1/2 inch by 11-inch paper.
 5. Provide heavy paper dividers with celluloid or plastic covered tabs for each separate warranty. Mark tabs to identify products or installation, and section number and title.
 6. Include on separate typed sheet, if information is not contained in warranty or guaranty form, a description of the product or installation, and the name, address, telephone number and responsible person for applicable installer, supplier and manufacturer.
 7. Identify each binder on front and spine with typed or printed inserts with title "WARRANTIES AND BONDS", the Project title or name, and the name of the Contractor. If more than one volume of warranties, guaranties and bonds is produced, identify volume number on binder.
 8. When operating and maintenance data manuals are required for warranted construction, include additional copies of each required warranty and guaranty in each required manual. Coordinate with requirements specified in Section 01783 - Operation and Maintenance Data.

1.8 TIME OF WARRANTY AND BOND SUBMITTALS

- A. **Submission of Preliminary Copies:** Unless otherwise specified, Contractor shall obtain preliminary copies of warranties, guaranties and bonds within ten days of completion of applicable item or Work.

- B. Submission of Final Copies: Contractor shall submit fully executed copies of warranties, guaranties and bonds prior to Notice of Completion.
- C. Date of Warranties and Bonds: Unless otherwise directed or specified, commencement date of warranty, guaranty and bond periods shall be the date established in the Notice of Completion.
 - 1. Warranties for Work accepted in advance of date stated in Notice of Completion: When a designated system, equipment, component parts or other portion of the Work is completed and occupied or put to beneficial use by University's Representative, by separate written agreement with Contractor, prior to completion date established in the Notice of Completion, Contractor shall submit properly executed warranties to University, as directed by University's Representative, within ten days of completion of that designated portion of the Work. Contractor shall list date of commencement of warranty, guaranty or bond period as the date established in the Notice of Completion.
- D. Duration of Warranties and Guaranties: Unless otherwise specified or prescribed by law, warranty and guaranty periods shall be not less than the guaranty period required by the Contract General Conditions, but in no case less than one year from the date established for completion of the Project in the Notice of Completion. See product Specifications Sections in Divisions 2 through 49 of the Project Manual for extended warranty and guaranty beyond the minimum one-year duration.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Requirements for Project Record Documents to be submitted for Contract closeout.

1.3 RELATED SECTIONS

- A. Section 01 33 00 - Submittals Procedures: General requirements for submission for shop drawings, product data, samples and quality control reports.

1.4 PROJECT RECORD DOCUMENTS

- A. Project Record Documents, General: Contractor shall not use Record Documents for construction purposes. Contractor shall protect from deterioration and loss in a secure, fire-resistive location; provide access to Record Documents for the Trustees' and the Architect's reference during normal working hours.
- B. Record Drawings: Contractor shall record information continuously as Work progresses. Contractor shall not conceal Work permanently until all required information is recorded. Contractor shall:
 - 1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately.
 - 2. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 - 3. Legibly and to scale, mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the work.
 - 4. Mark new information that is important to the University, but was not shown on Contract Drawings or Shop Drawings. Record actual construction, including:
 - a. Measured depths of foundations and footings encountered, measured in relation to finish First Floor datum.
 - b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent ground improvements.
 - c. Field changes of dimension and detail.
 - d. Details not on original Contract Drawings. Application of copies of details produced and provided by Architect during construction will be accepted.
 - e. Permanent Room names and Room numbers.
 - 5. Note related Change Order numbers where applicable.
 - 6. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
 - 7. Store Record Documents separate from documents used for construction.

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- C. Record Specifications: Contractor shall record changes made by Addenda and Change Orders. In PART 2 - PRODUCTS in each Section, Contractor shall legibly mark and record in red ink actual Products installed or used, including:
1. Manufacturer's name and product model or catalog number.
 2. Product substitutions or alternates utilized.
- D. Submission:
1. Contractor shall keep Project Record Documents current, as they will be reviewed for completeness by Architect, Inspector, and University's Representative as condition for certification of each Progress Payment Application.
 2. Prior to the date of the Notice of Completion, Contractor shall submit marked Record Documents to Architect for review, approval and further processing.

PART 2 - PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

Not Applicable to this Section.

END OF SECTION

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Administrative and procedural requirements for instructing University's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems and equipment.
 - 2. Training in proper operation and maintenance of systems, subsystems, and equipment installed under the Contract.

1.3 RELATED SECTIONS

- A. Section 01 78 23 - Operation and Maintenance Data: Operating and maintenance instructions to be used during training and demonstration.

1.4 SUBMITTALS

- A. Instruction Program: Contractor shall submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Contractor shall include learning objective and outline for each training module. Contractor shall:
 - 1. Make the operations and procedures manuals available for use during the training sessions.
 - 2. Schedule submission of instruction program to allow sufficient time for receipt, review and acceptance of instruction program by the Architect and the University's Representative and shall be not less than three weeks prior to proposed date of first training session.
 - 3. Submit, at completion of training, three complete training manuals for University's use.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Contractor shall include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Attendance Record: For each training module, Contractor shall submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, Contractor shall submit results and documentation of performance-based test.
- E. Demonstration and Training Video Record: Contractor shall submit two copies at end of each training session.

1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: Contractor shall engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and University's Representative for number of participants, instruction times, and location. Facilitator shall be firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

- B. Instructor Qualifications: Contractor shall engage qualified instructors to instruct University's personnel how to adjust, operate, and maintain systems, subsystems, and equipment not part of a system. Instructors shall be factory-authorized service representatives, complying with requirements in Section 01450 - Quality Control, experienced in operation and maintenance procedures and training.
 - 1. System manufacturers shall provide qualified instructor to describe system design, operational requirements, criteria, and regulatory requirements.
 - 2. University's Representative will furnish Contractor with names and positions of participants.

1.6 COORDINATION

- A. Coordination of Instruction Schedule: Contractor shall coordinate instruction schedule with University's operations. Contractor shall adjust schedule as required to minimize disrupting University's operations.
- B. Coordination of Instructors: Contractor shall coordinate instructors, including providing notification of dates, times, length of instruction time, and course content. Contractor shall allow for 30 days written notice to University's Representative.
- C. Coordination with Operation and Maintenance Data: Contractor shall coordinate content of training modules with content of approved emergency, operation, and maintenance manuals.
 - 1. Contractor shall not submit instruction program until operation and maintenance data have been reviewed and accepted by Architect and copies given to University's Representative.
 - 2. Contractor shall coordinate review of operation and maintenance data to make operation and maintenance data available at least two weeks prior to date scheduled for initial training session.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Contractor shall develop an instruction program that includes individual training sessions for each system and operating products not part of a system, as required by Division 2 through 48 Specification Sections. Contractor shall include instruction on operational interfaces between systems.
- B. Schedule of Training Sessions: Contractor shall arrange to have training conducted on consecutive days, with no more than six hours of training scheduled for any one day. Concurrent classes will not be acceptable.
- C. Training Sessions, General: Contractor shall develop a learning objective and teaching outline for each session. Contractor shall include a description of specific skills and knowledge that participant is expected to master. Training sessions shall progress logically. Each training session shall be comprised of time spent both in the classroom and at specific location of subject equipment or system. As a minimum, Contractor shall ensure that each training session covers the following subjects for each item of equipment and system:
 - 1. Familiarization:
 - a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
 - b. Check out the installation of the specific equipment items.
 - c. Demonstrate the unit and indicate how all parts of the specifications are met.
 - d. Answer questions.
 - 2. Safety:
 - a. Using material previously provided, review safety references.
 - b. Discuss proper precautions around equipment.
 - 3. Operation:
 - a. Using material previously provided, review reference literature.
 - b. Explain all modes of operation (including emergency).
 - c. Check out University's personnel on proper use of the equipment.

4. Preventive Maintenance:
 - a. Using material previously provided, review preventive maintenance (PM) lists including:
 - 1) Reference material.
 - 2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
 - b. Demonstrate how to perform Preventive Maintenance tasks.
 - c. Demonstrate to University's personnel what to look for as indicators of equipment problems.
 5. Corrective Maintenance:
 - a. List possible problems.
 - b. Discuss repairs--point out special problems.
 - c. Open up equipment and demonstrate procedures, where practical.
 6. Parts:
 - a. Show how to use previously provided parts list and order parts.
 - b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
 7. Local Representatives:
 - a. Where to order parts: Name, address, telephone.
 - b. Service problems:
 - 1) Who to call.
 - 2) How to get emergency help.
 8. Operation and Maintenance Manuals:
 - a. Review any other material submitted.
 - b. Update material, as required.
- D. Classroom Training for Operations Personnel:
1. Using projected drawings and photographs, describe and discuss equipment locations in plant and present operational overview of systems. Thoroughly discuss operating and maintenance manuals.
 2. Describe purpose and plant function of equipment and systems.
 3. Describe operating theory of equipment.
 4. Describe start-up, shutdown, normal operation and emergency operating procedures, including discussion of system integration and electrical interlocks, if any.
 5. Identify and discuss safety items and procedures.
 6. Describe routine preventive maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
 7. Describe operator detection, without test instruments, of specific equipment trouble symptoms.
 8. Describe required equipment performance test procedures and intervals.
 9. Describe routine disassembly and assembly of equipment if applicable (as determined by University's Representative on case-by-case basis) for purposes such as operator inspection of equipment.
- E. Classroom Training for Maintenance and Repair Personnel:
1. Theory of operation.
 2. Description and function of equipment.
 3. Start-up and shutdown procedures.
 4. Normal and major repair procedures.
 5. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
 6. Routine and long-term calibration procedures.
 7. Safety procedures.
 8. Preventive maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
- F. Field Training for Operations Personnel:
1. Identify locations of equipment components and controls.

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2. Review of component functions and theory of operation.
 3. Identifying piping and flow options.
 4. Identifying valves and explain their functions at various settings.
 5. Identifying instrumentation:
 - a. Location of primary element.
 - b. Location of instrument readout.
 - c. Discuss purpose, basic operation, and information interpretation.
 6. Discuss, demonstrate, and perform standard operating procedures and round checks, including system start-up and shutdown procedures.
 7. Review and perform safety procedures.
 8. Perform the required equipment exercise procedures.
 9. Discuss and perform preventive maintenance activities.
 10. Identify and review safety items and perform safety procedures, if feasible.
- G. Field Training for Maintenance and Repair Personnel: In addition to field training specified above for operations personnel, include the following:
1. Describe normal repair procedures.
 2. Perform routine disassembly and assembly of equipment, if applicable, for inspections and tests.
 3. Perform routine maintenance and repair tasks, including mechanical and electrical operations for troubleshooting, adjustments and calibration.
- H. Presentation Media:
1. Presentations may utilize computer-generated, projected graphics utilizing Microsoft PowerPoint software, including animation as appropriate to enhanced presentation and viewer interest. Graphics shall include text and still and moving images. PowerPoint presentation shall be suitable for incorporation into video record of instruction.
 2. Each session shall include mock-ups, samples and other visual aids as appropriate.
 3. Each session shall include printed handouts and notes for each participant.
 4. Produce sufficient printed materials to provide minimum of five unused copies for University's use in subsequent training programs.

PART 3 - EXECUTION

3.1 INSTRUCTION

- A. Preparation. Contractor shall:
5. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.
 6. Set up instructional equipment at instruction location.
- B. Scheduling: Contractor shall provide instruction at mutually agreed on times. For equipment that requires seasonal operation, Contractor shall provide similar instruction at start of each season. Contractor shall:
1. Schedule training through University's Representative.
 2. Schedule training at time and location convenient to University, with at least 14 calendar days' advance written notice to University's Representative.
- C. Training Sessions: Contractor shall conduct classroom and field training sessions presenting content specified in Article 2.1, titled "Instruction Program," above.
- D. Evaluation: At conclusion of each training session, Contractor shall assess and document each participant's mastery of module by use of written examination or performance-based demonstration test.
- E. Cleanup. Contractor shall:
1. Collect used and leftover educational materials and deliver to University as directed by University's Representative.
 2. Remove instructional equipment.

3. Restore systems and equipment to condition existing before initial training use.

END OF SECTION

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01 80 00 – Performance Requirements

Third Party Verified Certification - LEED Certification

New construction shall be designed and implemented to achieve LEED for New Construction Gold Certification. Design and construction teams are to provide all necessary services to complete the full certification process. All costs to achieve certification shall be the responsibility of the project team.

Performative Modeling

With each new construction or major renovation design submittal, the design / construction team shall complete the following iterative modeling at a minimum:

- Predictive Energy Modeling: Site EUI benchmarked against other projects of similar type and size.
- Predictive Daylight Modeling: The University prioritizes the use of daylighting in all regularly occupied spaces (unless indicated otherwise programmatically). While avoiding glare/contrast is necessary, spaces should meet the most current IESNA standards for daylight autonomy (300 – 3000 lux) at the work plane. Design Teams should demonstrate spatial daylight autonomy through the use of annual computer simulations.
- Predictive Water Use: For both indoor and outdoor water, the project should be benchmarked against other projects of similar size and type using a theoretical baseline.

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SECTION 02 20 00 – EARTHWORK FOR BUILDINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Preparing and grading subgrades for slabs-on-grade within the limits of the building structure.
 - 2. Excavating and backfilling for buildings and exterior planters
 - 3. Subsurface drainage backfill for walls.
 - 4. Import and export of earth fill material.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Refer to the Civil Drawings for Earthwork specification for work outside the limits of the building.

1.3 DEFINITIONS

- A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed.
- B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.
- D. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.
- E. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.
- F. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

1.4 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Samples: 20 lb samples, sealed in airtight containers, of each proposed fill and backfill soil material from borrow sources cleared by the environmental consultant. The Geotechnical Engineer shall inspect the borrow area and approve import soils.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.
- B. Testing and Inspection Service: Owner will employ a qualified independent Geotechnical Engineering testing agency to classify proposed on-site and borrow soils, to verify that soils comply with specified requirements and to perform required field and laboratory testing and inspections. See Drawing S102 for the required special inspections.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings". Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, consultants, Geotechnical Engineer, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least three (3) working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.
- D. The Geotechnical Engineer for this project is Earth Systems Pacific. A copy of the Geotechnical Engineering Study, dated July 19, 2021 prepared for this project is available at the Architect's office.

1.6 PROJECT CONDITIONS

- A. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shutoff services if lines are active.
- B. Visit the site to become familiar with existing site conditions and the contents of the data presented in the soil investigation report. The Contractor shall make his own interpretation of the data contained in the report and shall not be relieved of liability under the contract for any loss he may sustain as a result of any variance between conditions indicated by or deduced from the report and the actual conditions encountered during the progress of the work.
- C. The existing grades as shown on the Drawings are approximate only. The Contractor shall accept the site as it exists prior to the start of construction and shall do all grading work necessary to accomplish the finish grades shown on the Drawings.

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- D. Materials are assumed to be earth material that can be worked with ordinary earthmoving equipment. If rock is encountered within the limits of the construction, adjustments will be made in the contract in accordance with the Owner's Representative's instructions. Rock is defined as any stone or boulder that cannot be removed with power equipment without using explosives.
- E. All known obstructions have been noted on the drawings. However, should active, inactive, or abandoned sewers, water piping, or other underground utilities or other obstructions be encountered which interfere with the work, relocate, cap off, or remove at Owner's expense in accordance with the Owner's Representative before work proceeds excepting that in an emergency affecting safety of life, work, or adjoining property, act at once without instructions to prevent injury or loss. If any utilities are the property of others than the Owner, notify and secure written consents from the party supplying and those receiving said service to proceed accordingly. At completion of work, turn over such consents to the Owner's Representative.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations. Import earth fill material shall be coarse grained (ASTM D 2488-06), nonexpansive soil having an Expansion Index no greater than 10 (ASTM D4829-07) and with sufficient binder to be stable in foundation and utility excavations and maintain specified elevation tolerances during paving operations.
- B. Satisfactory Soil Materials: ASTM D2487-06 soil classification groups GM, GC, SW, SP, SC and SM (ASTM D 2488-06); free of rock or gravel larger than 3 inches in any dimension, debris, waste, vegetation and other deleterious matter.
- C. Unsatisfactory Soil Materials: ASTM D2487-06 soil classification groups CL, CH, ML, MH, and PT. If encountered during grading, these soils should be removed from construction areas unless specifically approved by the Geotechnical Engineer. Materials may be blended with satisfactory soil materials if authorized by the Geotechnical Engineer.
- D. Backfill and Fill Materials: Geotechnical Engineer shall approve soil materials used as fill or backfill. Onsite materials used as fill should be free from organic material, hazardous materials, unsuitable fill debris and other deleterious substances. Fill material shall not contain rocks, blocky material, or lumps over 6 inches in maximum dimension, nor more than 15 percent material larger than 2 inches. The use of on-site soil shall be approved by the Geotechnical Engineer.
- E. Retaining Wall Backfill: Clean course sand or gravel as approved by geotechnical engineer.

- F. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448-08, coarse aggregate grading size 57, with 100 percent passing a 1½ inch sieve and not more than 5 percent passing a No. 8 sieve.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.
- B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick minimum, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
 - 1. Tape Colors: Provide tape colors to utilities as follows:
 - a. Red: Electric.
 - b. Yellow: Gas, oil, steam, and dangerous materials.
 - c. Orange: Telephone and other communications.
 - d. Blue: Water systems.
 - e. Green: Sewer systems.

PART 3 EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Tree protection is specified in the Division 2 Section "Protection of Existing Improvements".

3.2 DEWATERING

- A. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area. The potential exists that water could be encountered during excavation. Refer to the revised Soils Engineering and Engineering Geology Report for site conditions and preliminary recommendations. If wet soils are encountered within the excavation, design and provide a de-watering system to mitigate the wet soil conditions.

- B. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

3.3 EXCAVATION

- A. Explosives: Do not use explosives.
- B. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.

3.4 STABILITY OF EXCAVATIONS

- A. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations.

3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1.2 inches. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspections.
- B. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.6 APPROVAL OF SUBGRADE

- A. Notify Geotechnical Engineer when excavations have reached required subgrade.
- B. When Geotechnical Engineer determines that unforeseen unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed. Unforeseen additional excavation and replacement material will be paid according to the Contract provisions for changes in Work.

3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to the Architect. Fill unauthorized excavations under other construction as directed by the Architect.

3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials in areas designated by Architect. Stockpile soil

materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 BACKFILL

- A. Backfill excavations promptly, but not before completing the following:
1. Acceptance of construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for record documents.
 3. Testing, inspecting, and approval of underground utilities.
 4. Concrete formwork removal.
 5. Removal of trash and debris from excavation.
 6. Removal of temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.10 FILL

- A. Preparation: Remove asphalt paving, vegetation, topsoil, debris, wet, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills. Extend the excavation a minimum of 5 feet beyond the edge of footings or floor slabs, whichever is further.
1. Create level benches on sloped surfaces steeper than 1 vertical to 5 horizontal so fill material will bond with existing surface. Perform benching in a manner that at least the outer 10 feet of existing slope, as measured from the face of the slope is removed.
 2. The Geotechnical Engineer shall inspect the surface of the ground to receive fill before fill is placed. No fill shall be placed until this surface has been approved by Geotechnical Engineer.
- B. When relative compaction tests indicate that fill densities are less than specified, the area shall be reworked and retested. Remove unsuitable soils and/or scarify, moisture condition, and compact until retests indicate the minimum compaction densities have been achieved.

3.11 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to at least optimum moisture content.
1. Do not place backfill or fill material on surfaces that are muddy.

2. Remove and replace, or scarify and air-dry satisfactory soil material that is too wet to compact to specified density. Stockpile or spread and dry removed wet satisfactory soil material.

3.12 COMPACTION

- A. Place backfill and fill materials in layers 6-8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.
- C. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D1557-07.
 1. Under structures, building slabs, and steps, compact fill material to a minimum of 90 percent maximum dry density.

3.13 SPECIAL GRADING PROCEDURE UNDER BUILDING

- A. Execute the following grading procedure under the entire area of the building and within the limits of the overexcavation area defined on the foundation plan.
- B. After removing existing structures, surface improvements, vegetation, large roots, debris, fill soils and other deleterious materials, excavate existing soils to the deeper depth of 2 feet below existing grade, 2 feet below the bottom of the footings, or through any disturbed/uncertified fill soils. Once the excavation is complete, notify the Geotechnical Engineer. After receiving the Geotechnical Engineer's approval, scarify the exposed surface of the excavation to a depth of 8", moisture condition to near optimum and recompact to a minimum of 90% of maximum dry density
- C. On site soils may be used for fill once they are cleaned of all organic material, rock, debris and irreducible material larger than 6 inches. The removed soils shall be blended together before they are placed as compacted fill. Alternatively, import soils, approved by the Geotechnical Engineer can be used as fill.
- D. Place a minimum of 18 inches of non-expansive fill at the top of fill material within the grading area.
- E. Place previously removed site soils and/or import soils, approved by the Geotechnical Engineer, in level lifts 6-8 inches in loose thickness. Moisture condition to near optimum moisture content and compact soil to 90% of the maximum density obtainable ASTM D1557-07.
- F. Extend the backfill operation, within each area of the building to finish pad elevation and place the 4 inch thick sand cushion under slabs-on-grade. Compact soil to 90% of the maximum density obtainable ASTM D1557-02.

3.14 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Grading Inside Building Lines: Finish subgrade to a tolerance of ½ inch when tested with a 10 foot straightedge.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency Services: Allow testing agency to continuously inspect and test the subgrade and fill or backfill layers. Do not proceed until test results for previously completed work verify compliance with requirements.
 - 1. Perform field in-place density tests according to ASTM 1556-07 (sand cone method) or ASTM D6938-07b (nuclear method).
 - 2. Footing Subgrade: Verification and approval of footing subgrades may be based on a visual comparison of each subgrade with related tested strata when acceptable to the Architect.
 - 3. Building Slab Areas: At subgrade and at compacted fill and backfill layers, perform field in-place density tests in 12 to 18 inch intervals and at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 4. Foundation Wall Backfill: In compacted backfill layers, perform at least one field in-place density test at 12 to 18 inch intervals for each 50 feet or less of wall length, but no fewer than two tests along a wall face.
- B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained.

3.16 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace material to depth directed by the Architect; reshape and recompact at optimum moisture content to the required density.
- C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

3.18 DUST CONTROL

- A. The contractor shall provide for dust control as required for the alleviation or prevention of any dust nuisance on or about the site or the borrow area of offsite if caused by the Contractor's operation either during the performance of the earthwork or resulting from the conditions in which the contractor leaves the site.

END OF SECTION 02 20 00

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SECTION 02 30 00 - SUBSURFACE INVESTIGATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes:

This section describes the subsurface conditions observed during the Geotechnical Investigation for this project. The Geotechnical Report is available for review upon written request from the Architect for the cost of printing.

B. Related Work:

1. Section 31 20 00 Earth Moving
2. Geotechnical Investigation Report as described in Section 31 20 00 – Earth Moving

1.2 QUALITY ASSURANCE

- A. Prior to bidding, bidders may request their own subsurface investigations to satisfy themselves as to site and subsurface conditions. Any such investigations shall be performed only under time schedules and arrangements approved in advance by the Architect.

1.3 OBSERVED SUBSURFACE CONDITIONS

A. Subsurface Conditions:

1. See the Geotechnical Investigation Report as described in Section 31 20 00 - Earth Moving

B. Actual Conditions:

1. The subsurface information provided is based on soil borings and observations made during the Geotechnical Investigation and are not a guarantee of actual subsurface conditions. If any variations or undesirable conditions are encountered during construction, the contractor shall notify the Geotechnical Engineer and the Architect so that supplementary direction can be given.
2. Existing utilities and facilities shown are based on record drawings and surface observations. The contractor shall verify locations of existing utilities to protect, identify for relocation, or remove, as necessary for the performance of work to complete this project.

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PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION 02 30 00

SECTION 03 10 00 - CONCRETE FORMWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in-place concrete formwork for buildings.
- B. Related Sections include the following:
 - 1. Division 3 Section "Concrete Reinforcing".
 - 2. Division 3 Section "Cast-in-Place Concrete".
- C. Design responsibility: designing formwork for structural stability and efficiency is contractor's responsibility.

1.3 QUALITY ASSURANCE

- A. ACI Publications: Comply with the following unless modified by the Contract Documents.
 - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 347, "Recommended Practice for Concrete Formwork."

PART 2 - PRODUCTS

2.1 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.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.

- 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 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. Chamfer Strips: Wood, metal, PVC, or rubber strips, $\frac{3}{4}$ by $\frac{3}{4}$ inch minimum.
- E. 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. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. 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. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

PART 3 - EXECUTION

3.1 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 member and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- 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. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 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.
- 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.
- M. Foundation concrete may be placed directly into neat excavations provided foundation trench walls are stable as determined by the Architect. In such case, the minimum formwork shown on the drawings is mandatory to insure clean excavations immediately prior to and during the placing of concrete.

3.2 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's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns and similar parts of Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
- 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.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and re-shoring.
- B. Plan sequence of removal of shores and re-shore to avoid damage to concrete. Locate and provide adequate re-shoring to support construction without excessive stress or deflection.

END OF SECTION 03 10 00

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete reinforcing, and placement procedures for buildings.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 3 Section "Concrete Formwork".
 - 2. Division 3 Section "Cast-in-Place Concrete".

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Steel Reinforcement Placing Drawings: Placing drawings that detail fabrication, bending, and placement. Include building foundation and floor plans, 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.
- C. Material Certificates: For steel reinforcement signed by manufacturers.
- D. Field quality-control test and inspection reports.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, unless modified by requirements in the Contract Documents.
 - 1. 2019 California Building Code (CBC)
 - 2. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 3. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 4. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

- B. Material Testing Service: The Owner will engage a testing agency acceptable to Architect and Structural Engineer to perform material evaluation tests. Materials and installed work may require testing and retesting at any time during progress of Work. Retesting of rejected materials for installed Work, shall be done at Contractor's expense.

PART 2 PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706, deformed.
- C. Plain-Steel Wire: ASTM A 82, as drawn.
- D. Deformed-Steel Wire: ASTM A 496.

2.2 REINFORCEMENT ACCESSORIES

- A. 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.

2.3 FABRICATING REINFORCING

- A. Fabricate steel reinforcing according to CRSI's "Manual of Standard Practice".

PART 3 EXECUTION

3.1 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement. 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. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

END OF SECTION 03 20 00

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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 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section specifies cast-in place concrete, including mix design, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
 - 1. Foundations and footings for buildings and exterior planter walls.
 - 2. Slabs-on-grade within the limits of the Buildings.
 - 3. Foundation walls for buildings.
 - 4. Slabs-on-Metal Decks
 - 5. Equipment pads and bases.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Portland Cement Concrete and Concrete Finishes" for exterior concrete paving and appurtenances.
 - 2. Division 3 Section "Concrete Formwork".
 - 3. Division 3 Section "Concrete Reinforcing".

1.03 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items, including admixtures, patching compounds, joint systems, and others if requested by Architect.
- C. Laboratory test reports for concrete materials and mix design tests.

- D. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. California Building Code (CBC)
 - 2. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
 - 3. ACI 318, "Building Code Requirements for Reinforced Concrete."
- B. Concrete Testing Service: The Owner will engage a testing agency acceptable to Architect to perform material evaluation tests and to review the concrete mixes. Mix designs shall be signed and stamped by a California registered Civil Engineer.
- C. Materials and installed work may require retesting at any time during progress of Work. Retesting of rejected materials for installed Work shall be done at Contractor's expense.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II. Use one brand of cement throughout Project unless otherwise acceptable to Architect.
- B. Fly Ash: ASTM C 618, Type F.
- C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
 - 1. Provide fine and coarse aggregates that have a proven history of non-reactivity and are classified as "Innocuous". Submit reactivity test reports in accordance ASTM C 289. Tests shall have been conducted on the aggregates within the past 6 months.
 - 2. Coarse aggregate: clean, hard, fine-grained, sound crushed rock, and/or washed gravel free of oil, organic matter or other deleterious substances as limited by Table 3, ASTM 33.
 - 3. Fine aggregate: washed natural sand free of deleterious substances as limited by table 1, ASTM C33.

4. Any suitable individual grading of coarse aggregates may be used provided the grading of combined aggregates shown in the table below is obtained.

Sieve number or size in inches	Percentage by weight One inch maximum
Passing a 1-inch	90-100
Passing a 3/4 inch	70-90
Passing a 3/8 inch	45-65
Passing a No. 4	31-47
Passing a No. 8	23-40
Passing a No. 16	17-35
Passing a No. 30	10-23
Passing a No. 50	3-10
Passing a No. 100	0-3

- D. Lightweight Aggregate: ASTM C 330, 3/8 inch nominal maximum aggregate size.
- E. Water: Potable and clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials or other substances deleterious to concrete or reinforcing steel.
- F. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.
- G. Water-Reducing Admixture: ASTM C 494, Type A.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
- a. WRDA, W.R. Grace & Co.
 - b. Pozzolith Normal or Polyheed, Master Builders, Inc.

2.03 RELATED MATERIALS

- A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217- inch- thick galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. Sand Cushion: Clean, manufactured or natural sand (ASTM D2488) of which less than 3 percent passes the No. 200 sieve.
- C. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154. Polyethylene sheet shall conform to ASTM E 1745 Class A (Plastics), not less than 15 mils (0.015 inch) in thickness and have a Water Vapor Transmission Rate (WVTR) less than or equal to 0.006 gr/ft²/hr as tested by ASTM E 96.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to the following:
 - a. Stego Wrap (15-mil) Vapor Barrier by Stego Industries
 - b. Perminator 15 mils by W.R. Meadows
 - c. Moistop Ultra 15 mils by Fortifiber
- D. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd., complying with AASHTO M 182, Class 2.
- E. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
 1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- F. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
 1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2.04 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 318, Section 5.2 and 5.3. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
 1. Slabs-On-Grade: Normal weight; 3,000 psi, 28-day compressive strength; water-cement ratio, 0.42 maximum; 3% maximum air content (including entrapped and entrained air).
 2. Slabs on metal deck: Light weight (110 pcf); 3,000 psi, 28-day compressive strength; water-cement ratio, 0.42 maximum; 3% maximum air content (including entrapped and entrained air).
 3. Building Foundations: 4,000 psi, 28-day compressive strength; water-cement ratio, 0.50 maximum (non-air entrained).

4. All other Concrete: 3,000 psi, 28-day compressive strength; water-cement ratio, 0.50 maximum (non-air entrained).

D. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: 4 inches \pm 1/2 inch
2. Reinforced foundation systems: Not less than 3 inches and not more than 5 inches.
3. Other concrete: 4 inches \pm 1 inch.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

2.05 ADMIXTURES

- A. Use water-reducing admixture in concrete, as required, for placement and workability.
- B. Use admixtures for water reduction in strict compliance with manufacturer's directions.

2.06 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.02 VAPOR RETARDER/BARRIER INSTALLATION

- A. General: Place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.

- B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape. Cover vapor retarder/barrier with sand cushion and compact to depth indicated.

3.03 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.
- D. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."
- E. Contraction (Control) 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. 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 before concrete develops random contraction cracks.
 - 2. If joint pattern is not shown, provide joints not exceeding 15 ft. in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
 - 3. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

3.04 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

- B. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.05 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
 - 1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into proceeding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
 - 1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
 - 2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 - 3. Maintain reinforcing in proper position on chairs during concrete placement.
- F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- G. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
 - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled 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. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 - 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
 - 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

3.06 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete,

or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

- C. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces that have received smooth-formed finish treatment not later than 1 day after form removal.
 - 1. 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. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.
 - 1. Combine one part Portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white Portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
 - 2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
- E. 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.

3.07 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, and where indicated.
 - 1. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, and where indicated.
 - 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
 - 1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied floor covering system.
 - 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10 foot-long straight edge resting on 2 high spots place anywhere on the surface does not exceed 3/16 inch.
- D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.
- E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.08 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete 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 to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.09 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.
- C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
- D. Provide moisture curing by the following methods:
 - 1. Keep concrete surface continuously wet by covering with water.
 - 2. Use continuous water-fog spray.
 - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
- E. Provide moisture-retaining cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

- F. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
 - 1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - 2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- G. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- H. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.
 - 1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.10 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.
- B. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
 - 1. Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
 - 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas 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.

- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
 - 1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
 - 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 - 3. Correct low areas in unformed surfaces 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. Proprietary underlayment compounds may be used when acceptable to Architect.
 - 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding

compound. Place dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- F. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.
- G. Repair methods not specified above may be used, subject to acceptance of Architect.

3.11 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner will employ a testing agency to perform tests and to submit test reports.
- B. Cementitious Material: The concrete supplier shall furnish to the testing agency certification that the cement proposed for use on the project has been manufactured and tested in compliance with the requirements of ASTM C 150 for Portland cement and ASTM C 595 or ASTM C 1157 for blended hydraulic cement, whichever is applicable. When a mineral admixture or ground granulated blast-furnace slag is proposed for use, the concrete supplier shall furnish to the testing agency certification that they have been manufactured and tested in compliance with ASTM C 618 or ASTM C 989, whichever is applicable. The concrete producer shall provide copies of the cementitious material supplier's Certificate of Compliance that represents the materials used by date of shipment for concrete. Cementitious materials without Certification of Compliance shall not be used.
- C. Sampling and testing for quality control during concrete placement may include the following, as directed by Architect.
 - 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 - c. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and

store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.

- d. Compressive-Strength Tests: ASTM C 39; samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, or not less than once for each 50 cubic yards of concrete, or not less than once for each 2,000 square feet of surface area for slabs or walls; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- E. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- G. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

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SECTION 05 12 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Structural steel.
2. Field-installed shear connectors.
3. Grout.
4. Compressible foam.

- B. Related Sections include the following:

1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 5 Section "Steel Deck".
3. Division 5 Section "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.
4. Division 9 Section "Painting" for surface preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

- D. 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.

1.4 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.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
 - 5. Provide shop drawings on 24"X36" sheets.
 - 6. Indicate "protected zones" on braces and gusset plates.
- C. Welding Procedure Specifications (WPS's): In accordance with AWS D1.1 requirements for each different welded joint proposed for use whether pre-qualified or qualified by testing. The WPS shall specify all applicable variables of AWS D1.1 and, in addition, reference the manufacturer's name and type of electrode with filler metal. A copy of the manufacturer's electrode data sheet shall be attached to the WPS.
- D. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Tension-control, high-strength bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
 - 6. Non-shrink grout.

1.5 QUALITY ASSURANCE

- A. Inspection of Welding: Inspection of all shop and field-welding operations, including the installation of automatic end-welded stud shear connectors, shall be made by a qualified welding inspector. Such inspector shall be a person trained and thoroughly experienced in inspecting welding operations. The inspector's ability to distinguish between sound and unsound welding shall be reliably established. The minimum

requirements for a qualified welding inspector shall be as those for an AWS-certified welding inspector (CWI), as defined in the provisions of the AWS QC1.

1. The ability of each welder to produce sound welds of all types required by the work shall be established by welder qualification satisfactory to the testing agency.
2. Welding inspection of structural welding shall conform to the requirements of AWS D1.1, except as modified by this section.
3. Welding inspection of Cold-formed steel members shall conform to the requirements of AWS D1.3.
4. The welding inspector shall make a systematic record of all welds. This record shall include in addition to other required records:
 - a. Identification marks of welders.
 - b. List of defective welds.
 - c. Manner of correction of defects.
5. The welding inspector shall check the material, equipment, details of construction and procedure, as well as the welds. The inspector shall also check the ability of the welder. The inspector shall verify that the installation procedure for automatic end-welded stud shear connectors is in accordance with the requirements of AWS D1.1 and the approved plans and specifications. The inspector shall furnish the Architect and Structural Engineer with a verified report that the welding is proper and has been done in conformity with AWS D1.1 and the approved plans and specifications. The inspector shall use all means necessary to determine the quality of the weld. The inspector may use gamma ray, magnaflux, trepanning, sonics or any other aids to visual inspection which the inspector may deem necessary to be assured of the adequacy of the welding.

B. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design".
4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
5. RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

1.6 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 erosion and deterioration.

1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
2. 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.

1.7 COORDINATION

- A. Furnish 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

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992
- B. Channels, Angles: ASTM A 36
- C. Plate and Bar: ASTM A 36 and A572 Grade 50.
- D. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B, structural tubing.
- E. Welding Electrodes: E70XX or E71XX (AWS D1.1, 70 KSI). Use low hydrogen electrodes for welding reinforcing steel.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex head steel structural bolts with splined ends; ASTM A563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers. Provide plain finish or galvanized, where indicated on each component.
- B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- C. Unheaded Anchor Rods: ASTM F 1554, Grade 55
 1. Configuration: Straight
 2. Nuts: ASTM A 563 heavy hex carbon steel.
 3. Plate Washers: ASTM A572 carbon steel.

4. Washers: ASTM F 436 hardened carbon steel.
5. Finish: Plain

D. Threaded Rods: ASTM A 307, Grade A .

1. Nuts: ASTM A 563 heavy hex carbon steel.
2. Washers: ASTM A 36
3. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.

2.3 PRIMER

- A. Primer: Primer specified in Section 9 – High Performance Coatings.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 Compressible Foam

- A. Expand polystyrene, cut to required size and shape and place adjacent to structural bracing where indicated.

2.6 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's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design
1. Camber structural-steel members where indicated.
 2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
 3. Mark and match-mark materials for field assembly.
 4. 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.
- 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 3, "Power Tool 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 and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for passage of other work 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. Base-Plate 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.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Slip critical.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

- a. Grind butt welds flush.
- b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.8 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 .
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 2, "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 dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.9 GALVANIZING

- A. Hot-Dip Galvanizing 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 are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.10 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports, and provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. 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.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 3. 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 base or bearing plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base or bearing 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 forming 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.
- 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 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Slip critical.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, 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 of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 - 4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 - 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 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.
 - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 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. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, [bearing plates,] and abutting structural steel.
- 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

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SECTION 05 31 00 - STEEL DECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof Deck.
 - 2. Composite Floor Deck
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete".
 - 2. Division 5 Section "Structural Steel"
 - 3. Division 9 Section "High Performance Coating."

1.3 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
- C. Product Certificates: For each type of steel deck, signed by product manufacturer.
- D. Welding certificates.
- E. Field quality-control test and inspection reports.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - 1. Power-actuated mechanical fasteners.

- G. Research/Evaluation Reports: For steel deck, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel." See Section 05120 for additional requirements.
- B. 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."

1.5 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

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Roof Deck:
 - a. ASC Profiles, Inc.
 - b. Epic Metals Corporation.
 - c. Verco Manufacturing Co.

2.2 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. 30, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33 (minimum yield 38 ksi), G60 zinc coating.
 - 2. Deck Profile: As indicated on drawings.
 - 3. Profile Depth: 1-1/2 inches

4. Design Uncoated-Steel Thickness: As indicated on drawings.
5. Span Condition: Triple span or more unless otherwise indicated.
6. Side Laps: overlapped

2.3 COMPOSITE FLOOR DECK

- A. Floor Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Floor Deck," in SDI Publication No. 30, and with the following:
 1. Galvanized and Shop-Primed Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 40 G60 zinc coating; cleaned, pretreated, and underside only primed with manufacturer's standard baked-on, rust-inhibitive primer. Primer to be compatible with finish coat specified in Division 9, Section "High Performance Coatings".
 - a. Color: white underside
 2. Deck Profile: As indicated on the drawings, vented.
 3. Profile Depth: 3 inches
 4. Design Uncoated-Steel Thickness: As indicated on the drawings.
 5. Span Condition: Triple span or more unless otherwise indicated.
 6. Side Laps: overlapped

2.4 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- C. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- D. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- E. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.
- F. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, 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.
- 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.

3.3 FLOOR AND ROOF DECK INSTALLATION

- A. Fasten roof-deck and floor-deck panels to steel supporting members with self-drilling #12 carbon steel sheet metal screws as indicated on the plans.
- B. Fasten roof-deck panels to cold-formed metal joists with self-drilling #10 carbon-steel sheet metal screws as indicated on the plans.
- C. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated on the plans.

- D. End Bearing: Install roof deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Butted.
- E. Roof Sump Pans: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and weld.
- F. End Bearing: Install floor deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:
 - 1. End Joints: Butted.
- G. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
- H. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- 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.

3.5 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 9 Section "High Performance Coatings".
- C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 31 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

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. Exterior non-load-bearing wall framing.
2. Interior non-load-bearing wall framing.
3. Roof rafter framing.
4. Ceiling joist framing.
5. Soffit framing.

B. Related Requirements:

1. Division 5 Section "Metal Fabrications" for miscellaneous steel shapes, and connections used with cold-formed metal framing.
2. Division 9 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Product Certificates: For each type of code-compliance certification for studs and tracks.

C. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

1. Steel sheet.
2. Mechanical fasteners.
3. Vertical deflection clips.
4. Miscellaneous structural clips and accessories.

- D. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- B. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CEMCO; California Expanded Metal Products Co.
 - 2. ClarkDietrich.
 - 3. Nuconsteel, A Nucor Company.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 - 1. Grade: ST33H or ST50H.
 - 2. Coating: G60.
- B. Steel Sheet for Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50 (340), Class 1 As required by structural performance Insert grade.
2. Coating: G60 (Z180) Insert coating designation.

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0538 inch.
 2. Flange Width: 1-5/8 inches and 2-1/2 inches.
 3. Section Properties: Per plans.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0538 inch.
 2. Flange Width: 1-1/4 inches and 2 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0538 inch.
 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications Insert dimension. Retain "Drift Clips" Paragraph below if drift clips are required to accommodate horizontal and vertical deflection of the primary structure.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Flange Width: 1-5/8 inches.
 3. Section Properties: Per plans.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Flange Width: 1-1/4 inches.
- C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0538 inch.
 2. Flange Width: 1 inch plus the design gap for one-story structures.

2.5 CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with standard holes, with stiffened flanges, per drawings.

2.6 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, per drawings.

2.7 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
1. Supplementary framing.
 2. Bracing, bridging, and solid blocking.
 3. Web stiffeners.
 4. Anchor clips.

5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.8 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by mechanically deposition according to ASTM B 695, Class 50.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; 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 AC01 as appropriate for the substrate.
 1. Uses: Securing cold-formed steel framing to structure.
 2. Type: Torque-controlled expansion anchor.
 3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 Class Fe/Zn 5, unless otherwise indicated.
 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- E. Welding Electrodes: Comply with AWS standards.

2.9 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.

- B. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.10 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 16 inches.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Connect vertical deflection clips to bypassing or infill studs and anchor to building structure.
 - 3. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at 96-inch centers indicated.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: 16 inches.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to studs and anchor to building structure.
 - 4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at 96-inch centers.

- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.
- C. Space joists not more than 2 inches from abutting walls, and as follows:
 - 1. Joist Spacing: As indicated on Drawings.
- D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.
 - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated. Fasten bridging at each joist intersection as follows:
 - 1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
 - 2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.8 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 2. Miscellaneous framing supports.
 - 3. Miscellaneous steel trim.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
 - 2. Division 5 Section "Pipe and Tube Railings."
 - 3. Division 9 Section "Painting" for field painting.

1.3 DEFINITIONS

- A. Exterior: Defined as the following:
 - 1. Areas, locations, and surfaces that are unprotected, or exposed to environmental elements.
 - 2. Areas, locations and surfaces within uncontrolled environments.
 - 3. Areas, locations and surfaces of unconditioned spaces, including below grade/underground, partially-exposed, or "covered" parking areas.

1.4 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering

calculation 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.

1.5 SUBMITTALS

- A. Product Data: For items specified.
- 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.
 2. Provide templates for anchors and bolts specified for installation under other Sections.
- C. Samples for Verification: For each type and finish of extruded nosing.

1.6 QUALITY ASSURANCE

- A. Reference Standards:
 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 6. 2019 California Energy Code, Part 6, Title 24 CCR
 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Welding: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code--Steel."
 2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.7 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. 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.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal fabrications that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- 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.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- C. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Anchor Bolts: ASTM F 1554, Grade 36.
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 9 painting Sections.
- C. Surface Preparation: SSPC-SP2 Hand Tool Clean and /or SSPC-SP3 Power Tool Clean.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Non-shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 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 true to line and level 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.
 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 where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be 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.
1. 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.

2.6 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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each

unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.8 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.
- C. Galvanize exterior miscellaneous steel trim and interior miscellaneous steel trim, where indicated.

2.9 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.10 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing steel and iron products. (50 microns min.)
 - 2. ASTM A 153, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- D. Field Finish: Comply with Division 9 Section "Painting" for field painting.

PART 3 - EXECUTION

3.1 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 bolts, 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.

3.2 INSTALLING 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.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 00

SECTION 05 51 33 - ALUMINUM LADDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Vertical ladders.
- B. Related Sections:
 - 1. Division 7 Section "Roof Accessories" for roof hatch.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product.
- B. Shop Drawings:
 - 1. Detail fabrication and erection of each ladder indicated. Include plans, elevations, sections, and details of metal fabrications and their connections.
 - 2. Provide templates for anchors and bolts specified for installation under other Sections.
 - 3. Provide reaction loads for each hanger and bracket.
- C. Qualification Data: Refer to Quality Assurance provisions for submittal requirements evidencing experience, certifications and resources.
- D. Verification Samples: For each finish specified, two samples, minimum size 6 inches square, represent actual product color.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR

3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Manufacturer Qualifications: A firm experienced in producing aluminum metal ladders similar to those indicated for this Project.
- C. Record of successful in-service performance.
- D. Sufficient production capacity to produce required units.
- E. Installer Qualifications: Competent and experienced firm capable of selecting fasteners and installing ladders to attain designed operational and structural performance.

1.5 WARRANTY

- A. Manufacturer's Warranty: 5 years.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Aluminum Ladders: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 1. Model 501 by O'Keeffe's Inc. (Basis of Design)
 2. Royalite.
 3. Alaco.
 4. Cotterman.
 5. ACL.
 6. Or equal (Reference substitution requirements in Section 01 60 00)

2.2 MATERIALS

- A. Aluminum Sheet: Alloy 5005-H34 to comply with ASTM B209.
- B. Aluminum Extrusions: Alloy 6063-T5, rungs to be 6063-T6 to comply with ASTM B221.
- C. Fasteners: As recommended by ladder manufacturer.

2.3 ALUMINUM LADDERS

- B. Product: Model 501 Heavy Duty Tubular Rails Fixed Access Aluminum Ladder by O'Keeffe's Inc.
 - 1. Rungs: Not less than 1-1/4 inches in section and 18-3/8 inches long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
 - 2. Rungs shall withstand a 1,500 pound load without deformation or failure.
 - 3. Heavy Duty Tubular Side Rails: Assembled from two interlocking aluminum extrusions no less than 1/8-inch wall thickness by 3 inches wide. Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth and burr-free surfaces. Channel side rails are not acceptable.

2.4 LADDER SAFETY POST OR SAFETY SYSTEM

- A. Retractable hand hold and tie off.
- B. SAF-T Climb Post w/ SAF-T-Climb kit

2.5 BRACKETS

- A. Floor Mounting Bracket 3/16" X 1 3/8" X 4 1/2" X 2" long standard alum. angle bracket
- B. Provide 3/8" aluminum intermediate wall bracket

2.6 SECURITY DOOR

- A. Standard security door for heavy duty tubular rails
- B. 1/8" thick aluminum door panel with 1/4" plate and hasp to accept pad lock.
- C. Door to be width of ladder + 3 1/2" X 7'6" mounted 4" above floor.

2.8 ALUMINUM FINISHES

- A. Mill Finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Anchor securely using fasteners specified by manufacturer or others of equivalent or greater strength and corrosion resistance.

END OF SECTION 05 51 33

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe and tube railings.
- B. Related Sections include the following:
 - 1. Division 5 Section "Cold Formed Metal Framing" for blocking for anchoring railings.
 - 2. Division 9 Section "Painting" for field painting.
 - 3. Division 32 Section "Concrete Paving" for related site concrete.

1.3 DEFINITIONS

- A. Exterior: Defined as the following:
 - 1. Areas, locations, and surfaces that are unprotected, or exposed to environmental elements.
 - 2. Areas, locations and surfaces within uncontrolled environments.
 - 3. Areas, locations and surfaces of unconditioned spaces, including below grade/underground, partially-exposed, or "covered" parking areas.

1.4 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails:
 - 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. 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.
 3. Infill of Guards:
 - a. Uniform load of 25 lbf/sq. ft. applied horizontally.
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation 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.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS

- A. Product Data: For the following:
 1. Manufacturer's product lines of mechanically connected railings.
 2. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Reference Standards:
 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 6. 2019 California Energy Code, Part 6, Title 24 CCR

7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Source Limitations: Obtain each type of railing through one source from a single manufacturer.
- C. Welding: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code--Steel."
- D. Appearance: Galvanized articles shall be free from uncoated areas, blisters, flux deposits, acid and black spots, and dross inclusions. Lumps, projections, globules, or heavy deposits of zinc which will interfere with the intended use of the material will not be permitted.

1.7 COORDINATION AND SCHEDULING

- 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.
- B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of pipe and tube railings that fails in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: 2 years.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Steel Pipe and Tube Railings:
 - 1. Local iron fabricators.
- B. Nonshrink, Nonmetallic Grout:
 - 1. 1107 Advantage Grout by Dayton Superior Chemical & Cement Products.
 - 2. Conset Grout by ChemMasters Specialty Construction Products.
 - 3. General-Purpose Grout by Symons.
 - 4. Or equal.

2.2 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.

2.3 STEEL AND IRON

- A. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
- B. Pipe: ASTM A 53, 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.
- C. Plates, Shapes, and Bars: ASTM A 36.
- D. Castings: Either gray or malleable iron, unless otherwise indicated.
 - 1. Gray Iron: ASTM A 48, Class 30, unless another class is indicated or required by structural loads.
 - 2. Malleable Iron: ASTM A 47.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

- 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 indicated and capable of withstanding design loads.
 - 1. 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.
- C. Anchors: Provide cast-in-place anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 9 Section "Painting".
- C. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 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. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

- C. 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.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded nonwelded either welded or nonwelded 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.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Form changes in direction as detailed.
- J. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive 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 railing members with prefabricated end fittings.
- 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 fillers made from crush-resistant material, or other means to transfer wall 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. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- 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 the 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.

2.8 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 2. Comply with ASTM A 123 for hot-dip galvanized railings.
 3. Comply with ASTM A 153 for hot-dip galvanized hardware.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed railings:
 1. Exterior Railings (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Interior Railings (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

3. Interior Railings Indicated to Receive Zinc-Rich Primer (SSPC Zone 1A): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 1. Do not apply primer to galvanized surfaces.
 2. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- F. Field Finish: Comply with Division 9 Section "Painting" for field painting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 3. 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.
- 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.

3.3 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 "Fabrication" Article whether welding is performed in the shop or in the field.

3.4 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8-inch buildup, sloped away from post.
- C. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ANCHORING RAILING ENDS

- A. Anchor railing ends to concrete and masonry with round flanges connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
- B. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

3.7 ADJUSTING AND CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.8 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 05 52 13

SECTION 06 10 00 - ROUGH CARPENTRY

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. Shear wall panels.
 - 2. Plywood backing panels.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Shear panels.
 - 2. Post-installed anchors.
 - 3. Metal framing anchors.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having

jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 SHEAR WALL PANELS

- A. Steel-Framed Shear Wall Panels: Site-fabricated assembly consisting of Structural I plywood, steel top and bottom plates, and steel studs.

2.2 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.3 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.4 METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Simpson Strong-Tie Co., Inc.
- B. Allowable design loads, as published by manufacturer, shall meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
- C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
 - 1. Use for interior locations unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough 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.
- D. Install shear wall panels to comply with manufacturer's written instructions.
- E. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Do not splice structural members between supports unless otherwise indicated.
- G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that

interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.
- I. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
 - 1. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

- A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00

SECTION 06 41 00 - INTERIOR ARCHITECTURAL LAMINATED CASEWORK

PART 1 - GENERAL

1. RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

2. SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate countertops.
 - 2. Plastic-laminate cabinets
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

3. DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

4. SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Cabinet Grade(s): Comply with Architectural Woodwork Standards 2nd Edition (2014)
 - a. Custom Grade cabinets
 - 2. Cabinet Types:
 - a. Frameless
 - 1. Reveal Overlay
 - 3. Cabinet and Drawer Hardware:
 - a. Provide touch latches and/or U-shaped wire pulls at all accessible casework or equally accessible pull hardware.

5. SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 2. Apply WI-certified compliance label to first page of Shop Drawings and follow Section 1, "Guidelines for Architectural Millwork Shop Drawing".
- C. Samples for Initial Selection: For each type of product indicated requiring product selection.
- D. Samples for Verification:
 - 1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
 - 2. Exposed cabinet hardware and accessories, one unit for each type and finish.
 - a. Hardware samples will be returned up on approval.
- E. Product Certificates: For each type of product, signed by product manufacturer.
- F. Woodwork Quality Standard Compliance Certificates for Product and Installation: WI-certified compliance certificates confirming conformance with Certified Compliance Program (CCP).
- G. Qualification Data: For Installer and fabricator.

6. QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations
 - 11. Architectural Woodwork Standards (Edition 3.1-2017)

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. 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. Shop is a licensee of WI's Certified Compliance Program.
- C. Installer Qualifications: Licensee of WI's Certified Compliance Program.
- D. Quality Standard: Unless otherwise indicated, comply with WI's "Manual of Millwork" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
 - 1. Before delivery to job-site, Millwork supplier:
 - a. Licensees of WI shall issue a certified compliance certificate indicating millwork products being furnished for this project, and certifying that these products and their installation, will fully meet requirements of grade or grades specified.
 - b. Non-Licensees of WI shall provide evidence that they have arranged for inspection by WI inspector after completion of fabrication and installation. If conditions are found to be compliant, inspector will issue Compliance Certificate indicating millwork products being furnished for this project, and certifying that these products and their installation, will fully meet requirements of grade or grades specified.
 - 2. Each elevation of casework and each countertop shall bear certified compliance label.
- E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

7. DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

8. PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where woodwork is 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 woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

9. 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.

10. WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of interior architectural woodwork that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 years.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

1. MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Active member of the Woodwork Institute licensed by WI to provide WI Certified Compliance Certificates and Labels for the products and materials specified in this Section.
 - 2. Substitutions: Under provisions of Section 1
- B. High-Pressure Decorative Laminate: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
 - 1. Wilsonart International; Div. of Premark International, Inc. (Basis of Design)
 - 2. Formica Corporation.
 - 3. Nevamar Company, LLC; Decorative Products Div.
 - 4. Or equal (Reference substitution requirements in Division 1 Section).

C. PLASTIC-LAMINATE COUNTERTOPS

- 1. High-Pressure Decorative Laminate Grade: HGS, 0.048 inches (1.2 mm) thick.
- 2. Provide Exterior grade plywood at wet locations and comply with following:
- 3. No seams shall occur within 18 inches of sink cut-outs.
- 4. Sink cut-outs shall be coated with opaque sealer.
- 5. Back splash shall coordinate with size of soap and paper tower dispensers for solid attachment.
- 6. Corners of tops shall be cut at 45 degrees if projecting or in pathway.
- 7. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
- 8. Colors: Per architect's selection from full range of standard colors
- 9. Edge Treatment: Self-edge banded or as detailed.
- 10. Medium-density fiber board (MDF). Do not use plywood.
- 11. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, on underside of countertop substrate.

- C. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 - 1. Medex, Medex NC, Medite II, or Arreis SDF by SierraPine Ltd.
 - 2. Weyerhaeuser Company; Premier Plus by Weyerhaeuser.
 - 3. Or equal (Reference substitution requirements in Division 1 Section).

- 2. CABINET HARDWARE
 - A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified and as modified below

 - B. Cabinet hardware: Subject to compliance with requirements, provide products by one of the following manufacturers if not listed under the specific component
 - 1. Accuride.
 - 2. Blum
 - 3. Hafele.
 - 4. Or equal (Reference substitution requirements in Division 1 Section).

 - C. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.

 - D. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.

 - E. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
 - 1. Provide a Schedule for the cabinet locks installed.
 - 2. Schedule to conform to BHMA A156.9 and include the following information:
 - a. Building that they are installed in.
 - b. Room number use Districts (sign) Room Numbers) where lock is installed in.
 - c. Manufacturer.
 - d. Model number of cylinder used.
 - 3. Format of Schedule: Excel.

 - F. Catches: Magnetic.

 - G. Drawer Slides:
 - 1. Type: Full extension.
 - 2. Static Load Capacity: As required by WI standards.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.

5. Features: Provide self closing/stay closed type.
6. Products:
 - a. Accuride International, Inc: www accuride.com.
 - b. Grass America Inc: www.grassusa.com.
 - c. Knappe & Vogt Manufacturing Company: www.knappeandvogt.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

- H. Hinges: European style concealed self-closing type, BHMA No. grade 1, steel with polished finish.
 1. Provide hinges with provision for attachment to all-glass doors where indicated.

3. MATERIALS
 - A. General: Provide materials that comply with requirements of WI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
 - B. Core and Substrates: Comply with the following:
 1. Medium-Density Fiberboard: ANSI A208.2, Grade MD.
 - C. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
 1. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semi-exposed edges.
 - D. High-Pressure Decorative Laminate (HPDL): NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 - E. Solid Polymer Components:
 1. Cast. Non-porous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specified.
 2. Superficial damage to a depth of 0.010 inch (.25 mm) shall be repairable by sanding and/or polishing.

4. CABINET HARDWARE AND ACCESSORIES
 - A. Adjustable Shelf Supports: Standard side-mounted system using multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.

- B. Grommets: Plastic, 2 inch diameter, locations as indicated. If locations are not indicated, as selected by Architect during shop drawing review. Doug Mockett, Sugatsune, Wood Technology, or equal.
 - C. Drawer and Door Pulls: For all, including accessible casework.
 - 1. "U" shaped wire pull, aluminum with satin finish, 4 inch centers.
 - D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish to key with door hardware. All doors and drawers to be lockable.
 - E. Hinges: Concealed (fully mortised) self-closing type, BHMA No. 652, steel with polished finish.
 - 1. Products: Blum or equal.
 - F. Drawer Slides: BHMA A156.9, B05091.
 - 1. Heavy Duty (Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides. Model 3640 by Accuride or equal.
5. MISCELLANEOUS MATERIALS
- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
 - B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
 - C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
 - D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Contact Adhesive: 250 g/L.
 - E. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

6. FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
 - 1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch Thick or Less: 1/16 inch.
 - 2. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch.
- D. Complete fabrication, including assembly, finishing, 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 7 days in advance of the dates and times woodwork fabrication will be complete.
 - 2. Trial fit assemblies at fabrication 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 indicated on Shop Drawings before disassembling for shipment.
- E. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, 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.
 - 1. Seal edges of openings in countertops with a coat of varnish.

7. PLASTIC-LAMINATE CABINETS

- A. WI Construction Style: Style A, Frameless.
- B. WI Construction Type: Type I, multiple self-supporting units rigidly joined together.
- C. WI Door and Drawer Front Style:
 - 1. Flush Reveal overlay.

- D. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Both sides of all shelves shall be 0.028 high pressure decorative laminate, regardless of location or exposure, and shall not span more than 34 inches.
 - 2. Shelves shall be retained with seismic clips.
 - 3. Cabinets shall be designed for full use of corners.
 - 4. Upper cabinets shall be at 4'-6" AFF max.

- E. Semi-Exposed Surfaces: Any one of following.
 - 1. Low pressure decorative polyester overlay.
 - 2. Low pressure decorative melamine overlay.
 - 3. HPL cabinet liner.
 - 4. Solid Phenolic core (SPC).

- F. Concealed Surfaces: Any of one of following.
 - 1. Solid Wood or Plywood: Any hardwood or softwood species, with no defects affecting strength or utility. Hardwood and softwood lumber kiln dried to 7 and 10 percent moisture content, respectively.
 - 2. Particleboard: ANSI A208.1, Grade M-2.
 - 3. Medium-Density Fiberboard: ANSI A208.2.
 - 4. Solid Phenolic core (SPC).

- G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Colors: Per Architect's selection from full range of standard colors

- 8. PLASTIC-LAMINATE COUNTERTOPS
 - A. High-Pressure Decorative Laminate Grade: HGS, 0.048 inches (1.2 mm) thick.

 - B. Provide Exterior grade plywood at wet locations and comply with following:
 - 1. No seams shall occur within 18 inches of sink cut-outs.
 - 2. Sink cut-outs shall be coated with opaque sealer.
 - 3. Back splash shall coordinate with size of soap and paper tower dispensers for solid attachment.
 - 4. Corners of tops shall be cut at 45 degrees if projecting or in pathway.

 - C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Colors: Per Architects selection from full range of standard colors

 - D. Edge Treatment: Self-edge banded

- E. Laminate Substrates: Medium-density fiber board (MDF). Do not use plywood.
- F. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, on underside of countertop substrate.

PART 3 - EXECUTION

1. PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back-priming.

2. INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Cabinets: Install without distortion so doors and drawers fit openings properly 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.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.

SECTION 07 21 16 - BUILDING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Batt insulation for filling perimeter window and door shim spaces. crevices in exterior wall and roof.
- B. Batt sound insulation in interior walls and partitions and above ceiling.

1.2 QUALITY CONTROL

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. ASTM C665 - Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- C. ASTM C1320 - Installation of Mineral Fiber Batt and Thermal Insulation for Light Frame Construction.
- D. ASTM C 578: Standard Specification for Rigid Cellular Polystyrene Thermal Insulation
- E. ASTM C 518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

- F. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. International Code Council Evaluation Service (ICC-ES), Evaluation Report.
- H. CCR - California Code of Regulations.
- I. CBC - California Building Code.

1.3 PERFORMANCE REQUIREMENTS

- A. Materials of this Section shall provide continuity of thermal and moisture barrier at building enclosure elements.
- B. Materials of this Section shall provide continuity of sound control where indicated or scheduled.

1.4 REGULATORY REQUIREMENTS

- A. Installation of insulation may only commence if insulation meets mandatory manufacturer certification to the California Energy Commission required by Title 24, Part 6, Section 118 of the California Code of Regulations (CCR) that insulation complies with Title 20, Chapter 4, Article 3 of the California Quality Standards for Insulating Materials.
- B. Insulation materials shall be certified in compliance with Business and Professions Code Section 19165.
- C. Insulation manufacturer shall be licensed by the California Department of Consumer Affairs, Bureau of Home Furnishing and Thermal Insulation according to Business and Professions Code, Section 19059.7.

1.5 SUBMITTALS

- A. Submit under provisions of Division 1 Section.
- B. Submit Product Data for each type of insulation specified.
- C. Submit manufacturer's certification that materials meet or exceed specified regulatory requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original packaging.
- B. Store and protect products in accordance with manufacturer's instructions. Store in a dry area and protect from water, direct sunlight, flame, and ignition sources. Do not install insulation that has been damaged or wet.
 - 1 In the event the board insulation becomes wet, wipe dry prior to installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS - INSULATION MATERIALS

- A. Certain Teed Corp.
- B. Manville Corp.
- C. Owens-Corning Fiberglass Corporation.

2.2 MATERIALS

- A. Batt Insulation: ASTM C665 preformed glass fiber batt, Type III, Class A, Category 1 with stapling flanges for attachment of blanket to applicable construction. Equivalent continuous roll membrane facing may be utilized in lieu of individual faced glass fiber batts. Provide R30 at ceilings and roofs, R19 at walls.
- B. Batt Sound Insulation: ASTM C665 preformed glass fiber batt, Type I unfaced, with flame spread of 25 or less, and a smoke density of less than 450 when tested in accordance with UL 723-03. Provide R-15, 3½ inch minimum thickness.
- D. Nails or Staples: Steel wire; electroplated; type and size to suit application.
- E. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inches wide.
- F. Support Wire: 16 gauge steel wire.
- G. Support Rods: 13 gauge, pointed spring steel length as required for stud spacing.
- H. Spindle Fasteners: Steel impale spindle and clip on flat metal base, [spot welded to substrate] [self adhering backing], length to suit insulation thickness, capable of securely and rigidly fastening insulation in place.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation are dry and ready to receive insulation.
- B. Do not install until building is fully enclosed to weather.

3.2 INSTALLATION

- A. Install insulation in accordance with insulation manufacturer's instructions and ASTM C739, C1149 and C1320. Cut "blow-in" holes only where specifically needed.
- B. Install batt insulation in exterior walls, ceiling furring, and roof spaces without gaps or voids. Where wood framed furred ceiling occur, install insulation over the furring strips rather than between the rafters.
- C. Install batt sound insulation in interior walls and where indicated or scheduled.
- D. Install blow-in insulation in cavities where it is unfeasible to install batt insulation.
- E. Trim insulation neatly to fit spaces.
- F. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation. Leave no gaps or voids.
- G. Install with factory-applied membrane facing on warm side of building spaces.
- H. Lap ends and side flanges of vapor barrier membrane over face of framing members.
- I. Extend vapor barrier on to any adjacent construction and tape seal edge of vapor barrier.
- J. Seal butt ends, lapped flanges, and tears or cuts in membrane with tape or another layer of membrane.
- K. Seal joints in vapor barrier caused by pipes, conduits, electrical boxes, and similar items penetrating vapor barrier.
- L. Face staple flange over flange of adjacent blanket to wood studs at maximum 6 inches on center.

- M. Friction fit sound insulation between studs as required to completely fill space between the wall finishes.
- N. Where wall finish does not occur, [use support rods spaced not more than 16 inches on center vertically at wood studs.] [use 16-gauge support wire through studs at not more than 16 inches on center vertically at metal studs.]
- O. Retain unsupported roof insulation to metal or concrete substrate with spindle fasteners at 24 inches on center.
- P. Remove all unused insulation and related products and dispose of correctly.

END OF SECTION 07 21 16

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SECTION 07 41 14 - METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Prefinished, prefabricated structural standing seam roof system with continuous interlocking seams.
 - 2. Prefinished Snap Edge Fascia
- B. Related Sections:
 - 1. Division Section 5 "Metal Fabrications.
 - 2. Division Section 7 Sheet Metal Flashing and Trim"
 - 3. Division Section 7 Section "Joint Sealants".

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel.
 - 1. Shop Drawings: Indicate thickness and dimensions of parts, fastenings and anchoring methods, details and locations of joints, transitions and other provisions necessary for thermal expansion and contraction.
 - 2. Indicate locations of field- and factory-applied sealant.
- B. Samples:
 - 1. Submit two samples, 12 inches long by full panel width, showing proposed metal thickness and seam profile.
 - 2. Submit standard color samples of metal for Architect's selection
 - 3. OR Match Existing Metal roofs on site. (Delete if not applicable)
- C. Qualification Data: For Installer, submit list of completed projects, with names and contact information for architects and contractors.

- D. Test Reports: Indicating compliance of products with project requirements.

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

B. Reference Standards:

1. ASCE 7: Minimum Design Loads for Buildings and Other Structures.
2. ASTM A653: Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process. (as applies)
3. ASTM A792: Steel Sheet, 55 % Aluminum Zinc Alloy Coated by the Hot Dip Process. (as applies)
4. ASTM E283 Tested.
5. ASTM E331 Tested
6. ASTM E1592: Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
7. ASTM E1646: Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
8. ASTM E1680: Rate of Air Leakage Through Exterior Metal Roof Panel Systems
9. UL-90 rated steel panel up to 18" o.c.
10. UL 263 fire resistance rated
11. UL 580: Class 90 Standard for Tests for Wind Uplift Resistance of Roof Assemblies.
12. UL-790 Class "A" fire rated
13. UL-1897 wind uplift.
14. ANSI-SPRI/FM 4435/ES Standard to comply with IBC
15. FM Approvals Standard 4471: Class 1 Panel Roofs.
16. SMACNA Architectural Sheet Metal Manual.

- C. Manufacturer Qualifications:
 - 1. Ten years' experience, minimum, in factory fabrication of metal panels.
 - 2. Manufacturer shall carry \$2,000,000 liability insurance, minimum, for metal panel system.
- D. Installer Qualifications: Submit list of completed projects, with names and contact information for Architects and Contractors.
 - 1. Three years' experience, minimum, in application of metal roof or wall panels.
 - 2. Five satisfactory projects with metal panel work of similar scope and complexity to Work of this Project.
 - 3. Installer must be approved by manufacturer in writing prior to bid.
- E. Testing Agency Qualifications: Agency compliant with ISO/IEC Standard 17025, or an accredited independent agency recognized by the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement or ANSI
- F. Test reports: Indicating compliance with project requirements.
- G. Mock-Ups:
 - 1. Visual Mock-Up: Construct mock-up, 10 by 10 feet or larger as required to show at least two pattern repeats, and in same orientation as determined by Architect
- H. Warranty Documentation.
- I. Insurance Documentation.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
 - 1. Keep panels and accessory items dry.
 - 2. Protect against damage and discoloration.
 - 3. Handle panels with non-marring slings.
 - 4. Support panels to prevent permanent deformation.
 - 5. Store panels above ground, with one end elevated for drainage.
 - 6. Protect panels against standing water and condensation between adjacent surfaces.
 - 7. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and keep sheets separate for air-drying.
 - 8. Painted panels shall be shipped with protective plastic sheeting or a strippable film coating between panels. Remove strippable film coating prior to installation. Do not allow strippable film coating to remain on panels in extreme heat, cold, or direct sunlight or other UV source.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard performance warranty, stating the following:
 - 1. Architectural finish:
 - a. 30-year non-prorated finish warranty
 - b. Will not chalk in excess of numerical rating of 8 when measured in accordance with standard procedures specified in ASTM D4214-98 method D659.
 - c. Will not peel, crack, chip, or delaminate.
 - 2. Metal substrate will not rupture, fail structurally, or perforate.
- B. Installer's Warranty: Warrant panels, flashings, sealants, fasteners and accessories against defective materials and/or workmanship, covering repairs required to maintain roof panels watertight and weatherproof with normal usage for two years following Project Substantial Completion date.
 - 1. Furnish written warranty, signed by installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Provide the following:
 - 1. PAC-CLAD, a Division of Carlisle Company.; Continuous interlock Standing Seam Panel
 - 2. PAC-CLAD, a Division of Carlisle Company: Snap Edge Fascia
 - 3. Or equal (Reference substitution requirements in Section 01 60 00.
- B. Performance Criteria:
 - 1. Wind Uplift: Panel system shall be ASTM E1592 tested under the supervision of an ANSI or ISO/IEC accredited laboratory and the laboratory shall issue the test report.
 - 2. Air Infiltration: <0.02 cfm per linear foot of joint when tested in accordance with ASTM E 283 at static test pressure differential of 20.0 psf.
 - 3. Water Penetration Under Static Pressure: No leakage through panel joints when tested in accordance with ASTM E 331 at static test pressure differential of 25.0 psf.
 - 4. Thermal Movements: Accommodate thermal movement without buckling, joint opening, overstressing components, failure of connections, or other detrimental effects, through the following temperature changes:
 - a. 120 degrees F, ambient.
 - b. 180 degrees F, material surface.

2.2 PANELS

- A. Panels: PAC-CLAD, a Division of Carlisle Company.; Continuous interlock Standing Seam Panel
 - 1. Material: Steel:
 - a. 22 Gauge: Yield strength 50,000 psi; with aluminum-zinc alloy coating conforming to ASTM A792, Class AZ50.
 - b. Thickness and yield strength as required for performance indicated; with aluminum-zinc alloy coating conforming to ASTM A792, Class AZ50
 - 2. Panel Width
 - 1) 16" o.c.
 - 3. Panel Rib Height:
 - a. 1 3/4"
 - 4. Panel Options:
 - a. Smooth Panel: (Standard)
 - 5. Panel Color/ Finish: Provide primer and top finish coat on exposed faces; provide primer and backer coat on concealed faces of panels.
 - a. As elected by Architect from 16 stock colors

2.3 SNAP EDGE FASCIA

- A. PAC Extended Snap Edge Fascia by Pac-CLAD (www.PAC-CLAD.com) (SELECT Model and type)
 - 1. Model: Built-up/ Modified Bitumen (BUM)
 - 2. Material: .050 Aluminum
 - 3. Size: 12 1/2"
 - 4. Color/ Finish:
 - a. (.050 Aluminum) As Selected by Architect from 29 Stocked colors

2.4 FRAMING AND SUBSTRATES

- A. Sheathing: See Section 6 "Rough Carpentry".
- B. Roofing Underlayment:
 - 1. Roofing Felt: 30 #
 - 2. Self-Adhering Sheet Underlayment: per manufacturers recommendation
 - 3. Slip Sheet: per manufacturers recommendation

2.5 CLIPS AND FASTENERS

- A. Bearing Plate: 22ga minimum See Metal Construction Association Technical Bulletin "Fastener Selection". Usually retain first option; retain second option if UL Class 90 is required.
- B. Fasteners: As recommended by manufacturer for performance indicated.

2.6 ACCESSORIES

- A. Trims and Flashings: Material, metal thickness, and finish to match panels. Profiles indicated in Drawings.
 - 1. Provide manufacturer's standard accessories and other items essential to completeness of standing seam roof installation.
- B. Panel Penetration Flashings: As recommended by panel manufacturer; designed to provide sufficient movement to prevent creation of points of fixity at penetrations.
- C. Sealant for Field Application: Factory applied sealant

2.7 FABRICATION

- D. Fabrication, General:
 - 1. Unless otherwise shown on Drawings or specified herein, fabricate panels in continuous lengths and fabricate flashings and accessories in longest practical lengths.
 - 2. Panels shall be factory correctively-leveled.
- E. Panels:
 - 1. Provide panels in full length from ridge to eave when possible.
 - 2. Where single length panels are not practical, provide mated swaged panels for positive joint end laps, shingled to accommodate water run-off (fabricated with overlap in direction of water flow).
 - 3. Roof panels shall have flush horizontal and vertical surfaces to facilitate sealing at terminations. Panel configurations which create voids and requiring supplemental closure devices shall not be considered acceptable.
 - 4. Engineer panels to use concealed anchors that permit expansion and contraction, except at eaves, end laps, ridges, valleys, hips and gables.
- F. Fabrication Tolerances:
 - 1. "oil canning" will not be accepted and is a cause for rejection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: With Installer present.
 - 1. Examine conditions and substrates on which metal panels are to be installed. Structural support or substrate shall be flat and plumb to avoid panel stresses and distortion.
 - 2. Prior to starting work, correct defects.
- B. Field Measurements:
 - 1. Coordinate field measurements and fabrication schedule with construction progress.
 - 2. Field measure prior to fabrication. Show recorded dimensions on shop drawings, including locations of shop-fabricated openings.
 - 3. If field measurements differ from drawing dimensions, notify Architect prior to fabrication.
- C. Substrate Tolerances: Deviations from flat plane shall not exceed the following.
 - 1. 1/4 inch in 20 feet.
 - 2. 1/2 inch across building elevation.
- D. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Substrate and Underlayment: Install according to approved shop drawings and metal panel manufacturer's recommendations.

3.3 INSTALLATION

- A. Panels and Trim: Comply with manufacturer's instructions for assembly, installation and erection for weather tight installation.
 - 1. Install according to approved shop drawings.
 - 2. Install panels in accordance with manufacturer's instructions and recommendations. Anchor securely in place using clips and fasteners spaced in accordance with manufacturer's recommendations for design wind load criteria.
 - 3. Comply with methods and recommendations of SMACNA Architectural Sheet Metal Manual for flashing configurations required.

4. Discrepancies between job site conditions and shop drawings shall be brought to the attention of the Architect for resolution.
 5. Cutting and Fitting:
 - a. Cut panels neat, square, and true with shearing action cutters. Torch or power saw cutting is prohibited.
 - b. Openings 6 inches and larger: Shop fabricate and reinforce to maintain original load capacity.
 - c. Openings less than 6 inches: Field cutting is acceptable.
 6. Dissimilar Metals or Materials:
 - a. Where panel or trim may come in contact with dissimilar metals or treated lumber, fabricate transition to facilitate drainage and minimize possibility of galvanic action. Galvanic action can cause panels and trim to fail prematurely.
 - b. At points of contact with dissimilar metal or treated lumber, coat panel and trim with protective paint or separate materials with a weatherproof underlayment.
 - c. Direct contact or run-off from CCA, ACQ, CA, or other treated lumber (outdoor wood) or fire retardant impregnated or treated wood shakes or siding can cause panels and trim to fail prematurely. Avoid contact with these materials.
- B. Accessories: Install trims, flashings, and roofing specialties according to Drawings and manufacturer's recommended details.
- C. Sealant Installation: Apply according to approved shop drawings and SMACNA Architectural Sheet Metal Manual recommendations.
1. Provide airtight and waterproof installation.
- D. Installation Tolerances:
1. Flatness: Match dimensional tolerances of framing or substrate.
- 3.4 CLEANING AND PROTECTION
- A. Repairs:
1. Touch up paint is not required for panels with scratches that do not expose metal.
 2. Panels or flashings with finish damage exposing metal or with substrate damage shall be replaced.
- B. Cleaning and Waste Management:

1. At completion of each day's work and at work completion, sweep panels, flashings, and gutters clean. Do not allow fasteners, cuttings, filings, or scraps to accumulate.
 2. Clean exposed surfaces of work promptly after completion of installation.
- C. Protect Work as required to ensure that roofing will be without damage at Final Completion.

END OF SECTION 07 41 14

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SECTION 07 54 19 - SINGLE-PLY PVC ROOFING – FULLY ADHERED

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fully adhered installation of a PVC, single-ply roofing membrane with flashings and other components to comprise a roofing system, including but not limited to the following.
 - 1. Wood Blocking
 - 2. Barrier Board
 - 3. Tapered Insulation
 - 4. Adhesive
 - 5. Termination Bars
 - 6. Fasteners
 - 7. Roofing Membrane
 - 8. Clad Edge Metal
 - 9. Flashings
 - 10. Walkway Pads

1.2 RELATED SECTIONS

- A. Related work:
 - 1. Section 07 62 00, Sheet Metal Flashing and Trim
 - 2. Section 07 92 05, Joint Sealants
 - 3. Division 22, Plumbing
 - 4. Division 23, Heating, Ventilating, and Air Conditioning
 - 5. Division 26, Electrical

1.3 SUBMITTALS

- A. List of Primary Roofing Components together with Product Data for each component and Material Samples of roofing membrane and exposed flashing materials
- B. Shop Drawings including seaming diagrams, membrane manufacturer's specifications and installation instructions, and applicable detail drawings
- C. Certificates of Compliance from manufacturers regarding material and code requirements
- D. Statement of Qualifications from installer, including Roofing Manufacturer's statement that installer is an authorized applicator of the specified roof system.

- E. Sample of Roofing Manufacturer's Full-System warranty.
- F. Sample copy of installer's water-tightness warranty
- G. Sustainable Design Submittals:
 - 1. Local/Regional Materials
 - 2. Recycled Materials

1.4 QUALITY ASSURANCE

- A. Manufacturer shall be firm with at least 25-years' experience in the production of the specified materials.
- B. Installer shall be an authorized or licensed installation I service agent for membrane manufacturer with minimum 5-years' experience installing the specified system.
 - 1. Installer shall certify that personnel assigned to this work have been trained and authorized by manufacturer in those procedures.
- C. Primary roofing system components shall be products by or as recommended by the roofing membrane manufacturer for use together in commercial roofing satisfying the requirements of this Section.
- D. Pre-Construction Conference. Convene at least two weeks prior to beginning this work.

1.5 CODE REQUIREMENTS

- A. The applicator shall submit evidence that the proposed roof system meets the requirements of the current edition of the California Building Code (CBC) and has been tested and approved or listed by the following test organizations. These requirements are minimum standards and no roofing work shall commence without written documentation of the system's compliance as required in the "Submittals" section of this Specification.
 - 1. Underwriters Laboratories, Inc. - Northbrook, IL
 - a. Class A assembly
 - 2. Factory Mutual Research Corporation (FM) - Norwood, MA
 - a. Class 1-90 (Attachment Criteria, Metal Deck)
 - b. Class 1-240 (Attachment Criteria, Structural Concrete Deck)

1.6 DELIVERY, STORAGE, AND HANDLING

- A. All products delivered to the job site shall be in original unopened containers or wrappers bearing all seals and approvals.

- B. Handle all materials to prevent damage. Place all materials on pallets and fully protect from moisture. Handle and store roofing materials and equipment in a manner to avoid permanent deflection of deck.
- C. Membrane rolls shall be stored lying down on pallets and fully protected from the weather with clean canvas tarpaulins. Unvented polyethylene tarpaulins are not accepted due to the accumulation of moisture beneath the tarpaulin in certain weather conditions which may affect the case of membrane weldability.
- D. Store liquid materials in their original undamaged containers in a clean, dry, protected location; away from direct sunlight; within the temperature range noted on the product data sheet.
- E. All flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow precautions outlined on containers or supplied by material manufacturer/supplier.
- F. All materials which are determined to be damaged by the Architect, Project Inspector or Roofing Manufacturer are to be removed from the job site and replaced at no cost to the Owner.
- G. Safety Data Sheets (SDS) shall be available at the job site at all times.

1.7 PROJECT CONDITIONS

- A. PVC materials may be installed under certain adverse weather conditions but only after consultation with the Roofing Manufacturer, as installation time and system integrity may be affected.
- B. Only as much of the new roofing as can be made weather tight each day, including all flashing and detail work, shall be installed. All seams shall be cleaned and heat-welded before leaving the job site that day.
- C. All work shall be scheduled and executed without exposing the interior building areas to the effects of inclement weather.
- D. All surfaces to receive new barrier board, membrane or flashings shall be dry. Should surface moisture occur, the Applicator shall provide the necessary equipment to dry the surface prior to application.
- E. All new and temporary construction, including equipment and accessories, shall be secured in such a manner as to preclude wind blow-off and subsequent roof or equipment damage.

- F. Uninterrupted waterstops shall be installed at the end of each day's work and shall be completely removed before proceeding with the next day's work. Waterstops shall not emit dangerous or unsafe fumes and shall not remain in contact with the finished roof as the installation progresses. Contamination membrane shall be replaced at no cost to the Owner.
- G. The Applicator is cautioned that certain PVC membranes are incompatible with asphalt, coal tar, heavy oils, roofing cements, creosote and some preservative materials. Such materials shall not remain in contact with PVC membranes. The Applicator shall consult the Roofing Manufacturer regarding compatibility, precautions and recommendations.
- H. Arrange work sequence to avoid use of newly constructed roofing as a walking surface or for equipment movement and storage. Where such access is absolutely required, the General Contractor or Construction Manager shall provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent areas. A substantial protection layer consisting of plywood over polyester felt or plywood over insulation board shall be provided for all new roof areas which receive rooftop traffic during construction.
- I. Prior to and during application, all dirt, debris and dust shall be removed from surfaces either by vacuuming, sweeping, blowing with compressed air and/or similar methods.
- J. The Applicator shall follow all safety regulations as required by OSHA and other applicable authority having jurisdiction.
- K. All new roofing waste material (i.e., scrap roof membrane, empty cans of adhesive) shall be immediately removed from the site by the Applicator and properly transported to a legal dumping area authorized to receive such material.
- L. The Applicator shall take precautions that storage and/or application of materials and/or equipment does not overload the roof deck or building structure.
- M. Flammable adhesives shall not be stored and not be used in the Vicinity of open flames, sparks and excessive heat.
- N. All rooftop contamination that is anticipated or that is occurring shall be reported to the Roofing Manufacturer to determine the corrective steps to be taken.
- O. The Applicator shall verify that all roof drain lines are functioning correctly (not clogged or blocked) before starting work. Applicator shall report any such blockages in writing to the Contractor and Architect for corrective action prior to installation of the roof system.

- P. Applicator shall immediately stop work if any unusual or concealed condition is discovered and shall immediately notify the Contractor and Owner of such condition in writing for correction.
- Q. Site cleanup, including both interior and exterior building areas which have been affected by construction shall be completed to the Owner's satisfaction.
- R. The Applicator shall conduct fastener pullout tests in accordance with the latest revision of the SPRI/ANSI Fastener Pullout Standard to help verify condition of deck/substrate and to confirm expected pullout values.
- S. Protective wear shall be worn when using solvents or adhesives or as required by job conditions.

1.8 WARRANTY

- A. Roofing Manufacturer's Fully System Twenty (20) Year (NDL) Material and Labor Warranty
 - 1. Upon successful completion of the work to the Roofing Manufacturer's and Owner's satisfaction, the warranty shall be issued. The Warranty shall be NonProrated and shall not exclude ponding water and no time limit shall be assigned for any such ponding water. Warranty shall not exclude foot traffic or storage on the roof system.
- B. Installer Five (5) Year Warranty
 - 1. The Installer shall supply the Owner a separate five year workmanship warranty. In the event any work related to roofing, flashing, or metal is found to be within the Installer warranty term, defective or otherwise not in accordance with the Contract Documents, the Installer shall repair that defect at no cost to the Owner. The Installer's warranty obligation shall run directly to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The components of the PVC adhesively fastened roof system are to be products of the Roofing Manufacturer as indicated on the Detail Drawings and specified in the Contract Documents.
- B. Components to be used that are other than those supplied or manufactured by the Roofing Manufacturer may be submitted for review and acceptance by the Roofing Manufacturer. Acceptance of any other product is only for a determination of compatibility with PVC products and not for inclusion in the warranty. The

specifications, installation instructions, limitations, and/or restrictions of the respective manufacturers must be reviewed by the Architect for acceptability for the intended use with PVC products.

2.2 MEMBRANE

A. Manufacturers

1. Sika Sarnafil (Basis of Design)
2. Duro-Last Roofing
3. Versico Roofing Systems
4. Or Approved Equal See Division 01 for substitution requirements

B. Membrane shall conform to ASTM D4434-96 (or latest revision), "Standard for Polyvinyl Chloride Sheet Roofing," Classification: Type II, Grade 1. (Sarnafil G410-60 Feltback is Basis of Design

C. Roofing Manufacturer shall certify in writing that the product supplied for this project has a minimum polymer thickness of 60 mils ASTM +/- tolerance for membrane thickness is not accepted. Membrane to have 9 oz feltback and part of the membrane sheet, not separate. Felt is not to be included as part of the overall membrane thickness.

D. Polymer thickness is to be measured using optical method measuring total polymer thickness between fibers or measuring overall sheet thickness according to ASTM D751- 95 and subtracting thickness of cross point reinforcing fabric. Polymer thickness shall be a minimum of thirty (30) mils above the reinforcements as documented by a third party source.

E. Membrane shall conform to the requirements of the "Energy-Star" program as outlined by the Department of Energy (DOE) and the Environmental Protection Agency (EPA) for reflectivity.

1. Reflective values shall be as follows:
 - a. Solar Reflectance (Albedo) 83%
 - b. Thermal Emissivity 90%
 - c. Solar Reflective Index 104%

F. As manufactured, membrane shall be fiberglass reinforced 9 oz feltback, have an integral, factory-applied lacquer coating to repel dirt and sustain reflectivity, and conform to the following physical properties:

1. Color to be "Energy-Smart" White.

<u>Parameters</u>	<u>ASTM Test Method</u>	<u>Minimum ASTM Requirement</u>
Overall Thickness, min., inches (mm)	D751	0.060 (1.50)
Breaking Strength, min., lbf/in. (KN/m)	D751	200 (35.0)
Elongation at Break, min.	D751	1.5%
Seam strength, min. (% of breaking strength)	D751	75
Breaking Strength, min., (% of original)	D751	90
Elongation, min., (% of original)	D751	90
Tearing Strength, min., lbf (N)	D1004	45.0 (200)
Low Temperature Bend, -40°F (-40°C)	D2136	45.0 (200)
Accelerated Weathering Test (Xenson Arc)	D2565	5.000 Hours
Discoloration (by observation)	Negligible	
Linear Dimensional Change	D1204	0.5% max.
Weight Change after Immersion in Water	D570	+ 3.0% max.
Static Puncture Resistance, 33 lbf (15kg)	D5602	Pass
Dynamic Puncture Resistance, 14.7 ft-lbf (20 J)	D5635	Pass

2.3 FLASHING MATERIALS

A. Wall/Curb Flashing

1. PVC Membrane Flashing (Fiberglass): Fiberglass reinforced membrane adhered to approved substrate using approved adhesive.

B. Perimeter Edge Flashing

1. PVC Clad Metal: PVC-coated, heat-weldable sheet metal capable of being formed into a variety of shapes and profiles. Clad metal is a 25 gauge, G90 galvanized metal sheet with a 20 mil (1 mm) unsupported PVC membrane laminated on one side. Color shall be white.

C. Miscellaneous Flashing

1. Reglet/Termination Bar: Heavy-duty, extruded aluminum flashing termination reglet used at walls and large curbs. Reglet is produced from 6063-T5, 0.10 inch - 0.12 inch (2.5 mm - 3.0 mm) thick extruded aluminum.
2. PVC Prefabricated Pipe Flashing: Prefabricated vent pipe flashing made from 0.048 inch (48 mil/1.2 mm) thick PVC membrane.

3. PVC Prefabricated Corners: Prefabricated outside and inside flashing corners made of 0.060 inch (60 mil/1.5 mm) thick membrane that are heat-welded to membrane or clad metal base flashings.
4. Multi-Purpose Sealant: Sika-Flex 1A sealant used at flashing terminations.
5. PVC Coverstrip: Precut flashing made from PVC polyester reinforced membrane. Used to coverstrip attachment bars and attachment discs.
6. Low-Rise Foam: A two-component polyurethane, low rise expanding foam adhesive used to attach barrier board and insulation to substrate. Consult product Data Sheets for additional information.

2.4 BARRIER BOARD AND TAPERED INSULATION

- A. Dens Deck, or approved equal.
 1. Siliconized gypsum, fire-tested hardboard with fiberglass-mat facers, 1 1/2" min. thick.
- B. Tapered Insulation
 1. A rigid isocyanurate foam insulation with black mat facers. Tapered insulation is available in 4 ft x 4 ft (1.2 m x 1.2 m) of 4 ft x 8 ft (1.2 m x 2.4 m) sizes and various thicknesses.

2.5 ATTACHMENT COMPONENTS

- A. Barrier Board Attachment Plate: Used with heavy duty fasteners to attach insulation/barrier boards to the roof deck. Attachment plate is a 3 inch (75 mm) round, 26 gauge stamping of SAE 1010 steel with an AZ. 55 Galvalume coating.
- B. Heavy Duty Fastener: #15 heavy-duty, corrosion-resistant fastener used with approved plates or attachment bar to attach insulation/barrier board or membrane to the wood roof deck. Heavy duty fasteners have a shank diameter of approximately 0.21 inch (5.3 mm) and the thread diameter is approximately 0.26 inch (6.6 mm). The driving head has a diameter of approximately 0.435 inch (11 mm) and is #3 Phillips design for positive engagement.
- C. Low-Rise Foam (Barrier Board and Insulation): A two component (Part A and B) polyurethane low-rise adhesive for bonding barrier board and insulation to approved compatible substrates. Consult Product Data Sheets for additional information. Application rates as recommended by roofing manufacturer.
- D. 2163 Adhesive: A highly elastomeric, low odor, VOC compliant, one step, low-rise urethane foam used to attach insulation to structural roof decks and other insulation boards.

- E. StaBond Adhesive: A solvent-based reactivating-type adhesive used to attach membrane to flashing substrate.
- F. 2121 Membrane Adhesive: A water-based adhesive used to attach the membrane to horizontal or near-horizontal substrates. Consult Product Data Sheets for additional information. Application rates are as follows:

APPLICATION RATES FOR FELTBACK MEMBRANE				
	Adhesive Rates – Gallons/100ft ² (Liters/Meters ²)			Approximate Sq. Ft./Pail (meter²)
	Substrate	Membrane	Total	
GP Dens-Deck®	1.75 (0.71)	+ 0 =	1.75 (0.71)	285 (26.48)

Notes:

- a) There is a significant increase in drying time due to an increase in humidity and/or a decrease in temperature. Do not install when outdoor or substrate temperatures during drying period are expected to fall below 40° F (5° C).
- b) Do not allow 2121 adhesive to skin-over or surface-dry prior to installation of membrane.
- c) Use a water-filled, foam-covered lawn roller to consistently and evenly press the membrane into the adhesive layer.

2.6 WALKWAY PROTECTION

- A. PVC Walk Tread: Polyester reinforced, 03096 inch (96 mil/2.4 mm), weldable membrane with surface embossment. Used as a protection layer from rooftop traffic.

2.7 MISCELLANEOUS ACCESSORIES

- A. Aluminum Tape: 2 inch (50 mm) wide pressure-sensitive aluminum tape used as a separation layer between small areas of asphalt contamination and the membrane and as a bond-breaker under the coverstrip at clad metal joints.
- B. Sealing Tape Strip: High quality solvent cleaner used for the general cleaning of residual asphalt, scuff marks, etc., from the membrane surface. Membrane cleaner is also used daily to clean seam areas prior to hot-air welding in tear off or dirty conditions or if the membrane is not welded the same day it is unrolled.

2.8 SEALANTS

- A. Multi-Purpose Sealant (for termination details).

- B. Depending on substrates, the following sealants are options for temporary overnight tie-ins:
 - 1. Mechanical attachment with rigid bars and compressed sealant.

2.9 MISCELLANEOUS FASTENERS AND ANCHORS

- A. All fasteners, anchors, nails, straps, bars, etc. shall be post-galvanized steel, aluminum or stainless steel. Mixing metal types and methods of contact shall be assembled in such a manner as to avoid galvanic corrosion. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins. All concrete fasteners and anchors shall have a minimum embedment of 1.25 inch (32mm) and shall be approved for such use by the fastener manufacturer. All miscellaneous wood fasteners and anchors used for flashings shall have a minimum embedment of 1 inch (25 mm) and shall be approved for such use by the fastener manufacturer.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION CONFERENCE

- A. The Roofing Installer, Contractor, Project Inspector, Architect, University Project Manager, and Roofing Manufacturer shall attend a pre-construction conference.
- B. The meeting shall discuss all aspects of the project including but not limited to:
 - 1. Construction schedule
 - 2. Contract conditions
 - 3. Coordination of the Work

3.2 SUBSTRATE CONDITION

- A. Roofing Installer shall be responsible for acceptance or provision of proper substrate to receive new roofing materials.
- B. Roofing Installer shall verify that the work done under related sections meets the following conditions:
 - 1. Roof drains and/or scuppers have been installed properly.
 - 2. Roof curbs, nailers, equipment supports, vents and other roof penetrations are properly secured and prepared to receive new roofing materials.
 - 3. All surfaces are smooth and free of dirt, debris and incompatible materials.
 - 4. All roof surfaces shall be free of water.

3.3 SUBSTRATE PREPARATION

- A. General: The roof deck and [existing] roof construction must be structurally sound to provide support for the new roof system. The Applicator shall load materials on the rooftop in such a manner to eliminate risk of deck overload due to concentrated weight. The Roofing Installer and Contractor with observation by the Project Inspector shall ensure that the roof deck is secured to the structural framing according to local building code and in such a manner as to resist all anticipated wind loads in that location.
- B. New Construction
 - 1. Steel Deck:
 - a. FM approved steel deck - The roof deck shall be 22 gauge (minimum) grade E and shall conform and be installed to meet the latest revision of FM's Loss Prevention Data Sheet 1-28 and the California Building Code (CBC) currently adopted version requirements
 - 2. Structural Concrete Deck
 - a. The roof deck shall be smooth, even, free of dust, dirt, excess moisture or oil and be structurally sound. Sharp ridges, other projections and accumulations of bitumen above the surface shall be removed to ensure a smooth surface before roofing. Any deteriorated decking shall be repaired.

3.4 SUBSTRATE INSPECTION

- A. A dry, clean and smooth substrate shall be prepared to receive the PVC adhered roof membrane system.
- B. The Roofing Installer shall inspect the substrate for defects such as excessive surface roughness, contamination, structural inadequacy, or any other condition that will adversely affect the quality of Work.
- C. The substrate shall be clean, smooth, dry, free of flaws, sharp edges, loose granules and foreign material, oil and grease. Roofing shall not start until all defects have been corrected.
- D. All roof surfaces shall be free of water.
- E. PVC membrane shall be applied over compatible and accepted substrates only.

3.5 BARRIER BOARD AND INSULATION INSTALLATION

- A. Barrier board and insulation shall be installed according to manufacturer's instructions.
- B. Barrier board and insulation shall be neatly cut to fit around penetrations and projections.

- C. Do not install more barrier board and insulation than can be covered with PVC membrane by the end the day or the onset of inclement weather.
- D. Mechanical Attachment
 - 1. Fasteners are to be installed consistently in accordance with fastener manufacturer's recommendations. Fasteners are to have minimum penetration into structural deck recommended by the fastener manufacturer and Roofing Manufacturer and FM requirements.
- E. Adhered Attachment
 - 1. With a utility knife, cut away the plastic plugs from the Sarnacol 2163 mixing head. Attach a mixing tip to the threaded mixing head. Place the cartridge into the applicator. At the beginning of the tube, some of the material should be pumped out initially to make sure of a proper mix. Apply using a gravity fed applicator or by hand with a dual component caulk gun over properly installed and prepared substrates in bands 12 inches (305 mm) on center. Bands are 1/4 to 1/2 inch (6 to 13 mm) wide before foaming. Adhesive will quickly, within 30 to 45 seconds at 60 to 80 degree F (15 to 27 degree C), transform from a liquid into a low rise foam. Immediately set insulation boards into wet adhesive. Do not allow the adhesive to skin over. Walk insulation boards into place to ensure full embedment. Within 5 to 15 minutes the boards are securely attached to the substrate. In warmer weather this process is a little quicker. In colder weather the process is a little slower. CAUTION: Walking insulation boards in immediately after placement into adhesive may cause slippage/movement until adhesive starts to set up. On roof slopes greater than 1/2 inch (13 mm) in 12 inches (305 mm), begin adhering insulation at low point and work upward to avoid slippage. One person should be designated to walk in, trim/slit and apply weight to all insulation boards to ensure adequate securement. Only areas that can be made completely watertight in the same day's operations shall be coated. Unused adhesive can be applied at a later date by simply replacing the mixing tip. For multiple layers of insulation spray adhesive over the base layer once fully secured and follow procedures above for attachment of each insulation layer.

3.6 INSTALLATION OF ROOFING MEMBRANE

- A. Make no deviation from the Manufacturer's Instructions, the Accepted Shop Drawings, and this Specification without prior written approval by the Architect.
- B. Apply membrane in accordance with manufacturer's instructions and requirements of the NRCA - Roofing and Water Proofing Manual - Fourth Edition specifications for the following single-ply roofing membrane systems.
 - 1. For Insulated Decks.

- C. The surface of the substrate shall be inspected prior to installation of the PVC roof membrane. The substrate shall be clean, dry, free from debris and smooth, with no surface roughness or contamination. Broken, delaminated, wet or damaged barrier boards shall be removed and replaced.
 - 1. Over the properly installed and prepared substrate, 2121 adhesive shall be poured out of the pail and spread using notched X inch x X inch x X inch (6 mm x 6 mm x 6 mm) rubber squeegees. The 2121 adhesive shall be applied at a rate according to the membrane manufacturer's requirements. No adhesive is applied to the back of the G410 feltback membrane. Do not allow adhesive to skin-over or surface-dry prior to installation of G410 feltback membrane.
 - 2. The G410 feltback roof membrane is unrolled immediately into the wet 2121 adhesive. Adjacent rolls overlap previous rolls by 3 inches (75 mm). This process is repeated throughout the roof area. Immediately after application into adhesive, each roll shall be pressed firmly into place with a water-filled, foamcovered lawn roller by frequent rolling in two directions. Do not allow adhesive to skin-over or surface-dry prior to installation of G410 feltback membrane.
 - a. Weld G410 coverstrips at all G410 feltback seams that do not have a factory selvage edge.
 - b. Notes:
 - 1) 2121 shall not be used if temperatures below 40° F (5° C) are expected during application or subsequent drying time.
 - 2) No adhesive shall be applied in seam areas. All membrane shall be applied in the same manner.

3.7 HOT-AIR WELDING OF SEAM OVERLAPS

- A. General
 - 1. All seams shall be hot-air welded. Seam overlaps 3 inches (75 mm) wide when automatic machine welding and 4 inches (100 mm) wide when handwelding except for certain details.
 - 2. Welding equipment shall be provided by or approved by the Roofing Manufacturer. All mechanics intending to use the equipment shall have successfully completed a training course provided by the Roofing Manufacturer's Technical Representative prior to welding.
 - 3. All membrane to be welded shall be clean and dry.
- B. Quality Control of Welded Seams
 - 1. The Roofing Installer shall check all welded seams for continuity using a rounded screwdriver. On-site evaluation of welded seams shall be made daily by the Roofing Installer to locations as directed by the Project Inspector or Roofing Manufacturer. One inch (25 mm) wide cross-section samples of welded seams shall be taken at least three times a day. Correct welds display failure from

shearing of the membrane prior to separation of the weld. Each test cut shall be patched by the Roofing Installer at no extra cost to the Owner.

3.8 MEMBRANE FLASHINGS

- A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Architect and Roofing Manufacturer. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at the Roofing Installer's expense. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces.
- B. Install discs according to the manufacturer's requirements with approved fasteners into the structural deck at the base of parapets, walls and curbs. Discs may be required by the Roofing Manufacturer at the base of all transition, peaks, and valleys according to the Roofing Manufacturer's details.
- C. The Roofing Manufacturer's requirements and recommendations and the specifications shall be followed. All material submittals shall have been accepted by the Roofing Manufacturer prior to installation.
- D. All flashings shall extend a minimum of 8 inches (0.2 m) above roofing level unless otherwise accepted in writing by the Architect and Roofing Manufacturer Technical.
- E. All flashing membranes shall be consistently adhered to substrates. All interior and exterior corners and miters shall be cut and hot-air welded into place.
- F. All flashing membranes shall be mechanically fastened along the counter-flashed top edge with batten bar at 6-8 inches (0.15-0.20 m) on center.
- G. PVC flashings shall be terminated according to the Roofing Manufacturer's recommended details.

3.9 PVC CLAD METAL BASE FLASHINGS/EDGE METAL

- A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Architect and Roofing Manufacturer. Acceptance shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Roofing Installer's expense.
- B. PVC clad metal flashings shall be formed and installed per the Detail Drawings.
 - 1. All metal flashings shall be fastened with two rows of post galvanized flat head annular ring nails 4 inches (100 mm) on center staggered. Fasteners shall penetrate the wood deck a minimum of 1 inch (25 mm).

2. Metal shall be installed to provide adequate resistance to bending and allow for normal thermal expansion and contraction.

C. Adjacent sheets of PVC clad shall be spaced $\frac{1}{8}$ inch (6 mm) apart. The joint shall be covered with 2 inch (50 mm) wide aluminum tape. A 4 inch minimum (100 mm) wide strip of PVC flashing membrane shall be hot-air welded over the joint.

3.10 METAL FLASHINGS

A. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:

1. Specification Section 07600
2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.

B. Metal, other than that provided by the Roofing Manufacturer, is not covered under the Roofing Manufacturer's warranty.

C. Complete all metal work in conjunction with roofing and flashings so that a watertight condition exists daily.

D. Metal shall be installed to provide adequate resistance to bending to allow for normal thermal expansion and contraction.

E. Metal joints shall be watertight.

F. Metal flashings shall be securely fastened into solid wood blocking. Fasteners shall penetrate the wood nailer a minimum of 1 inch (25mm).

G. Airtight and continuous metal hook strips are required behind metal fascias. Hook strips are to be fastened 12 inches (0.3 m) on center into the wood nailer or masonry wall.

H. Counter flashings shall overlap base flashings at least 4 inches (100 mm).

I. Hook strips shall extend past wood nailers over wall surfaces by 1-1/2 inch (38 mm) minimums and shall be securely sealed from air entry.

3.11 WALKWAY INSTALLATION

A. Roofing membrane to receive Walkway Tread shall be clean and dry. Apply continuous coat of adhesive to the deck sheet and the back of Walkway in accordance with the Roofing Manufacturer's technical requirements and press walkway into place with a water-filled, foam-covered lawn roller. Clean the deck membrane in areas to be welded. Hot-air weld the entire perimeter of the Walkway to the PVC deck sheet. Check all

welds with a rounded screwdriver. Re-weld any inconsistencies. Check all existing deck membrane seams that are to be covered by Walkway with rounded screwdriver and reweld any inconsistencies before Walkway installation.

3.12 COMPLETION

- A. Prior to demobilization from the site, the work shall be reviewed by the Project Inspector, Architect and the Roofing Manufacturer. All defects noted and noncompliances with the Specifications or the recommendations of the Roofing Manufacturer shall be itemized in a punch list. These items must be corrected immediately by the Roofing Installer to the satisfaction of the Project Inspector, Architect and Roofing Manufacturer prior to demobilization.

3.13 FIELD QUALITY ASSURANCE

- A. Membrane Manufacturer's Representative shall be present at the acceptance inspection of the prepared substrate.
- B. Membrane Manufacturer's Representative shall make regular, in-progress, inspections while this work is in progress.
- C. Upon completion of the installation and installer's delivery to manufacturer a certification that Work is complete and accordance with the contract specifications and manufacturer's requirements, Membrane Manufacturer's Representative shall make inspection of the installed roof system
- D. Membrane Manufacturer's Representative shall submit written report upon completion of each activity. After its completion inspection, report shall be accompanied by an executed full system warranty as specified in this Section.

3.14 CLEANING

- A. Remove rubbish, debris, and waste materials and legally dispose of off the project site.

3.15 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

END OF SECTION 07 54 19

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Parapet caps
 - 2. Reglets, Roof Edge Flashings
 - 3. Riser/ curb caps
 - 4. Sheet metal flashing and trim not specifically specified in other sections.
- B. Related Sections:
 - 1. Division 7 Section "Joint Sealants"
 - 2. Division 7 Section "Flexible Sheet Flashing"
 - 3. Division 9 Section "Painting" for field painting.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

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- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
1. Identification of material, thickness, weight, and finish for each item and location in Project.
 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 4. Details of termination points and assemblies, including fixed points.
 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counter-flashings as applicable.
 7. Details of special conditions.
 8. Details of connections to adjoining work.

1.5 QUALITY ASSURANCE

- A. Reference Standards:
1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 6. 2019 California Energy Code, Part 6, Title 24 CCR
 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- C. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

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D. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sheet metal flashing and trim that fails in materials or workmanship within specified warranty period.
 1. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: 2 years.
- B. Installer's Warranty: 1 year.

2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653, G90 coating designation; structural quality.
 - a. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
 - 2. Surface: Smooth, flat and mill phosphatized for field painting.
 - 3. Gage: 24 GA. minimum unless noted otherwise to be thicker. Except mechanical curb and deck caps to be 22 GA.
 - 4. Color: As selected by Architect from manufacturer's full range.
 - 5. 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.

2.2 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 sheet metal flashing and trim 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.

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- C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C 1311, single—component, solvent—release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- G. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 MANUFACTURED SHEET METAL FLASHING AND TRIM

- 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. Products:
 - a. Fry Reglet Corporation.
 - b. Heckmann Building Products Inc.
 - c. Hickman, W. P. Company.
 - d. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
 - e. Or equal.
 - 2. Material: Galvanized steel, minimum 0.022 inch thick.
 - 3. Provide one of the following types depending on substrates:
 - a. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 - b. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
 - c. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 - d. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 - e. Accessories:

- 1) Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
- 2) Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.4 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim 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. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Sealed Joints: Form non-expansion 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 from compatible, noncorrosive metal.
- E. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- F. Do not use graphite pencils to mark metal surfaces.

PART 3 –EXECUTION

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3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim 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 sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 - 5. Install sealant tape where indicated.
 - 6. Torch cutting of sheet metal flashing and trim 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 with bituminous coating or by other permanent separation as recommended by SMACNA where flashing and trim will contact wood, ferrous metal, or cementitious construction.

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2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- 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. Fastener Sizes:
1. Wood: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
 2. Concrete: 1/4" Tapcon concrete screw anchors 1 1/4" minimum penetration galvanized for interior use, stainless steel for exterior use. Hammer drill hole 3/16" deeper than penetration.
- E. Seal joints as shown and as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg. F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."
- F. 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 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.
 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.
 4. Copper Soldering: Tin edges of uncoated copper sheets using solder for copper.

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Construction Documents

3.3 MISCELLANEOUS FLASHING INSTALLATION

- A. Overhead-Piping Safety Pans: Suspend pans independent from structure above as indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.
- B. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.5 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.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 62 00

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SECTION 07 65 00 – FLEXIBLE SHEET FLASHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Flexible sheet flashing for windows, door, and other openings and where indicated on Drawings.
- B. Related Sections include the following:
 - 1. Division 7 Section "Joint Sealants" for joint-sealant materials and installation.

1.3 SUBMITTALS

- A. Concurrent Review Requirements: Submit submittals of this section with doors and windows sections.
- B. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of flexible sheet flashing.
- C. Shop Drawings: Show locations and extent of flexible sheet flashing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- D. Samples: For the following products:
 - 1. 12-by-12-inch square of flexible sheet flashing.
- E. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.
- F. Qualification Data: For Installer.

- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for flexible sheet flashing.

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Installer Qualifications: A firm that is acceptable to flexible sheet flashing manufacturer for installation of flexible sheet flashing required for this Project.
- C. Source Limitations: Obtain flexible sheet flashing materials through one source from a single manufacturer.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockup with doors and windows.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to flexible sheet flashing including, but not limited to, the following:
 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. Review and discuss the flashing to be coordinated with the finishing of doors and windows.
 3. Review, discuss, and coordinate the interrelationship of flexible flashing with other exterior wall components. Include provisions for sealants and fasteners.

4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by flexible sheet flashing manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Store rolls according to manufacturer's written instructions.
- E. Protect stored materials from direct sunlight.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flexible Sheet Flashing: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.
 1. Vycor Plus by WR Grace (Basis of Design).
 2. FortiFlash by Fortifiber.
 3. FlexWrap and StraightFlash by DuPont.
 4. Or equal.

2.2 FLEXIBLE SHEET FLASHING

- A. Self-Adhered, cross-laminated high-density polyethylene (HDPE) sheet, backed by aggressive pressure-sensitive rubberized asphalt adhesive.
 1. Thickness: 25 mil minimum per ASTM D3767, Method A.
 2. Low temperature flexibility: Unaffected at minus 45 degrees F. per ASTM D1970.
 3. Elongation, ultimate failure of rubberized asphalt: 200 percent minimum per ASTM D412.

4. Cracked cycling 100 cycles: Unaffected at minus 25 degrees F. per ASTM C836.
5. Lap adhesion at minimum application temperature: 60 plf width per ASTM D1876 modified.
6. Adhesion to concrete at minimum application temperature: 60 plf width per ASTM D903.
7. ICBO: ER-6141.
8. Recommended exposure limit: 30 days.
9. Perm-A-Barrier by Grace is not acceptable.

2.3 AUXILIARY MATERIALS

- A. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by flexible sheet flashing manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
 1. Verify that concrete has cured and aged for minimum time period recommended by flexible sheet flashing manufacturer.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install flexible sheet flashing in accordance with the manufacturer's written instructions, AAMA Publication 2400, and the applicable code.

END OF SECTION 07 65 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof hatches.
 - 2. Roof curbs.
 - 3. Pre-manufactured rooftop sleeper support blocks
- B. Related Sections include the following:
 - 1. Division 5 Section "Aluminum Ladders" for metal ladders and supports, to roof hatches.
 - 2. Division 7 Section "Single Ply PVC Roofing"
 - 3. Division 9 Section "Painting" for field finishes.

1.3 SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. 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. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
- C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Reference Standards:

1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Title 24 CCR, Part 12 - 2019 California Reference Standards Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of roof accessories that fails in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: 2 years.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Roof Hatches: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Bilco Company (The). (Basis of Design)
 - 2. Milcor Inc.; a Gibraltar Company.
 - 3. Nystrom, Inc.
 - 4. O'Keeffe's Inc.
 - 5. ThyCurb; Div of Thybar Corporation.
 - 6. Or equal (Reference substitution requirements in Section 01 60 00)

- B. Roof Hatch Guard Rail System: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Bilco Company (The). (Basis of Design)
 - 2. Or equal (Reference substitution requirements in Section 01 60 00)

- C. Roof Curbs: Subject to compliance with requirements, provide products by one of the following manufacturers.
 - 1. Custom Curb, Inc.
 - 2. LM Curbs.
 - 3. ThyCurb; Div. of Thybar Corporation.
 - 4. Or equal. See 01 60 00 for substitution requirements

- D. Pre-manufactured rooftop sleeper blocks
 - 1. Dura-Blok roof top supports as manufactured by Eaton
 - 2. Or approved equal. See Section 01 60 00 for substitution requirements

2.2 METAL MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653, G90 coated and mill phosphatized for field painting.
 - 1. Comply with Division 9 Section "Painting" for field finishes.

- B. Steel Shapes: ASTM A 36, hot-dip galvanized to comply with ASTM A 123, unless otherwise indicated.

2.3 MISCELLANEOUS MATERIALS

- A. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.
- B. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
- C. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
- D. Roofing Cement: ASTM D 4586, non-asbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.4 ROOF HATCHES

- A. General: Fabricate roof hatches with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gaskets and equip with corrosion-resistant or hot-dip galvanized hardware.
- B. Product: Type S or E depending on size by Bilco.
 - 1. Type: Galvanized steel double-leaf lid.
 - 2. Size: As indicated on Drawings.
 - 3. Integral Curb and Framing Material: Galvanized steel sheet, 0.079 inch thick.
 - 4. Finish: Comply with Division 9 Section "Painting".

2.5 ROOF HATCH GAURDRAIL

- A. Product: BL-GUARD 2.0 Hatch Rail System
 - 1. Type: For Single Leaf Roof Scuttle with 1" standard cap flashing.
 - 2. Size: For 30"x36" Roof Hatch, as indicated on the Drawings, overall rails system size of 3'-9 3/4"x 3'-11 3/8".

2.6 ROOF CURBS

- A. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner

joints, with integral metal cant and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers.
 - a. Custom Curb, Inc.
 - b. LM Curbs.
 - c. ThyCurb; Div. of Thybar Corporation.
 - d. Or equal.
2. Material: Galvanized steel sheet, 0.079 inch thick.
 - a. Factory prime painted.
 - b. Finish: Comply with Division 9 Section "Painting".
3. Liner: Same material as curb, of manufacturer's standard thickness and finish.
4. Factory install wood nailers at tops of curbs.
5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Factory insulate curbs with 1-1/2-inch- thick, cellulosic or glass-fiber board insulation.
7. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
8. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

2.7 PRE-MANUFACTURED ROOFTOP SLEEPER BLOCKS

- A. General: Use pre-manufactured sleeper blocks that are made from 100% recycled rubber with reflective strip on each side for visibility and bolted in channel galvanized for easy support attachment security. and accessory configuration for each condition shall be as recommended by the manufacturer.
- B. DB series for condensate lines
 1. DB5 (load is less than 200#'s per support) Size to be 6" wide by 4" tall, select widths as required to support the number of conduits and pipes supported

2.8 FINISH

- A. Galvanized Steel: Field finish per Division 9 Section "Painting".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
 - 2. Verify dimensions of roof openings for roof accessories.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Install roof accessories to fit substrates and to result in watertight performance.
- C. 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 manufacturer.
 - 1. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.
- D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
- E. Roof Hatch Installation:
 - 1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.
- F. Roof Curb Installation:
 - 1. Set roof curb so top surface of roof curb is level

- G. f. Roof top sleeper support block installation.
 - 1. Install blocks level and at spacing indicated but not less than required to maintain load limits
 - 2. Install per, manufacturers requirements and recommendations
- H. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

3.3 TOUCH UP

- A. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Division 9 painting Sections.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.4 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 07 72 00

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SECTION 07 84 00 - FIRESTOPPING

PART 1- GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Firestop devices and systems tested in accordance with ASTM E814 (ANSI/UL 1479) and listed in UL Fire Resistance Directory.
 - 2. Fire resistant construction joints.
 - 3. Dynamic partition head, wall, barrier details.
 - 4. Fire safing at edge of slab and curtain wall conditions.
 - 5. Penetrations through fire-rated floors, walls, and shafts.
 - 6. Duct and damper firestops.
 - 7. Intumescent wraps and pads at receptacle boxes and recessed items within fire rated walls.
- B. This Project is a US Green Building Council "LEED" project.
 - 1. Select adhesives and sealants meeting LEED requirements.
 - 2. Select materials to maximize use of recycled materials.
 - 3. Select locally or regionally fabricated products wherever possible.
- C. Select adhesives, primers and sealants meeting Cal-GREEN requirements.
- D. Related Sections:
 - 1. Section 01 73 29 - Cutting and Patching; Repair of openings with original materials.
 - 2. Section 07 21 00 – Thermal Insulation: Batt, mineral wool continuous, and EXP insulation types.
 - 3. Section 078100 – Spray Applied Fireproofing.
 - 4. Section 078123 - Intumescent Fireproofing.
 - 5. Section 09 29 00 – Gypsum Board: Acoustical Insulation, Mineral wool fire rated.
 - 6. Section 09 29 00 - Gypsum Board
 - 7. Division 21 – Fire Suppression.
 - 8. Division 22 – Plumbing.
 - 9. Division 23 – Heating, Ventilating, and Air Conditioning.
 - 10. Division 26 – Electrical.

1.2 REFERENCES

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Firestops"
- C. Test Requirements: UL 2079, "Tests for Fire Resistance of Building Joint Systems"
- D. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

1. UL Fire Resistance Directory:
 - a. Firestop Devices (XHJI)
 - b. Fire Resistance Ratings (BXRH)
 - c. Through-Penetration Firestop Systems (XHEZ)
 - d. Fill, Voids, or Cavity Material (XHHW)
 - e. Forming Materials (XHKU)
 - f. Joint Systems (XHBN)
 - g. Perimeter Fire Containment Systems (XHDG)
 2. Alternate Systems: "Omega Point Laboratories Directory" (updated annually).
- E. Test Requirements: ASTM E 1966, "Standard Test Method for Fire Resistive Joint Systems"
- F. Test Requirements: ASTM E 2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus"
- G. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops"
- H. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials"
- I. ASTM D6904, "Standard Practice for Resistance to Wind Driven Rain for Exterior Coatings Applied on Masonry"
- J. ASTM C 679, "Standard Test Method for Tack-Free Time of Elastomeric Sealants"
- K. ASTM G21, "Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi"
- L. California Building Code
- M. NFPA 101 - Life Safety Code
- N. NFPA 70 - National Electric Code
- O. NFPA 80 - Standard for Fire Doors and Other Opening Protectives
- P. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives

1.3 SYSTEM DESCRIPTION

- A. General: Make firestop and smoke seal assembly selections that comply with UL Fire Resistance Directory, authority having jurisdiction, and applicable codes for:
1. Materials, fabrication, and installation of firestops and smoke seals.
 2. Fire containment.
 3. Fire resistant construction joints.
 4. Dynamic partition head details.

5. Edge of slab and curtain wall conditions.
 6. Penetrations through fire-rated floors, walls, and shafts.
 7. Duct and damper firestops.
 8. Intumescent wraps and pads at receptacle boxes and recessed items within fire rated walls.
 9. Coordinate with mechanical, electrical and drywaller to provide single manufacturer for all firestopping materials.
- B. Firestop Voids and Openings in Following Locations:
1. Duct, cable, cable tray, conduit, piping, and other penetrations through floor slabs (except on-grade slabs) and through fire rated walls and partitions.
 2. Penetrations of vertical shafts, pipe chases, elevator shafts, and utility shafts.
 3. Openings between floor slab edges and exterior walls, including glass and aluminum curtain walls.
 4. Openings, gaps, and cracks at abutting fire rated assemblies and components, such as wall-to-wall and wall-to-floor including overhead floor and roof decks.
 5. Blank openings into or through fire rated floors and walls.
 6. Other locations indicated or scheduled.
- C. Design Requirements:
1. Insulated Piping and Duct Penetrations: Install firestop systems intended for use with type of insulation on penetrating item.
 - a. Install firestop systems intended for use with type of insulation on penetrating item.
 - b. If compatible firestop system is unavailable, remove insulation at contact area with firestop material
 - c. Coordinate with trades who installed insulation to ensure proper re-sealing of cut edges of insulation.
 2. Provide Products that Do Not Deteriorate when Exposed to Following Conditions:
 - a. Plumbing and Wet-Pipe Sprinkler Systems: Moisture-resistant through-penetration firestop.
 - b. Exposed to View:
 - 1) Flame-spread value of less than 25 and smoke-developed value of less than 450, ASTM E84.
 - 2) Compatible with applied finishes.
- D. F and T Rating Requirements: Conform to F and T ratings, ASTM E 814 (ANSI/UL 1479).
1. Comply with applicable codes and authority having jurisdiction.
 2. F Ratings: Equal to fire resistance rating of assembly being penetrated but not less than one hour.
 3. T Ratings: Equal to F ratings, except where a T rating for the firestop condition is specifically exempted by the applicable code.
- E. Provide W-rated fire/smoke stop system (Class 1) for wet areas.
- F. Testing Requirements:
1. Utilize systems and materials tested and approved by UL or other nationally recognized independent testing agency acceptable to authorities having jurisdiction.

2. Determine fire ratings in accordance with ASTM E814 (ANSI/UL 1479), ASTM E 1966 (ANSI/UL 2079), and ASTM E 2307 for through penetration and joint firestops, ASTM E119 (UL263) for fire rated assemblies, and as required by applicable codes and authority having jurisdiction.
- G. Large openings may be closed with same type construction as adjacent floor, roof, and wall assembly.
- H. Sealing around penetrations fire rated assemblies without approved firestop system is not permitted. Methods and materials not permitted include but are not limited to:
 1. Joint compound at gypsum board assemblies.
 2. Mortar at masonry and concrete assemblies.
 3. Use of joint sealants.
- I. Whenever finished firestop materials are scheduled to receive finish paint or other coatings, test compatibility of firestop materials with coatings to be applied.

1.4 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. Submit manufacturer's certification stating:
 1. Each penetration of fire rated walls and floor, partition heads, and edge of slabs will be firestopped with a firestopping system tested by UL or other recognized testing agency for substrate and penetrating item.
 2. Authorities having jurisdiction have approved firestopping systems for this project.
 3. Products and Classifications Schedule:
 - a. Provide tabular form schedule for firestops, fire containment, and fire-resistant construction joints.
 - b. Schedule to identify:
 - 1) Construction penetrated including fire resistance rating.
 - 2) Penetrating item.
 - 3) Products and manufacturers included in each system.
 - 4) Form material used.
 - 5) Firestop classification and description from UL or other nationally recognized independent testing agency acceptable to authority having jurisdiction.
 - 6) Fire containment and fire resistant construction joint description.
 - 7) F, T, and W ratings where applicable
 - c. Update schedule periodically to include addition and changes.
- C. Informational Submittals: Submit following:
 1. Test Reports: Copy of UL or other acceptable testing agency report illustrating each system and device as tested and approved.
 2. List of generic descriptions and product names and manufacturers included in each system including form material, containment system, gang assemblies, means of controlling size of annular space, and sealer, topcoat, or intumescent materials.

3. Certifications specified in this section.
 4. Qualification Data: Manufacturer's and installer's qualification data.
 5. Manufacturer's field reports.
- D. LEED Data: Refer to Section 018113 - Sustainable Design Requirements for submittal requirements to achieve overall LEED v4.0 goals.
1. Credit MR 4, Recycled Content: The recycled content (by weight) of the major components shall be identified and documented.
 2. Credit MR 5, Regional Materials: The manufacturing locations and origin of raw and salvaged materials shall be identified and documented if sourced within a straight-line 500 mile total travel distance of the project site using a weighted average determined through the following formula: $(\text{Distance by rail}/3) + (\text{Distance by inland waterway}/2) + (\text{Distance by sea}/15) + (\text{Distance by all other means}) = 500 \text{ miles}$
 3. Credit IEQ 4.1, Low-Emitting Materials, Adhesives and Sealants: All field-applied adhesives and sealants used on the interior of the building shall meet the volatile organic compound (VOC) and chemical component limitations as defined in Section 01 81 13 "Sustainable Design Requirements". VOC contents shall be identified and documented.

1.5 **QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum five years experience.
- B. Firestop Manufacturer: Do not use firestop material produced by any manufacturer who will not agree to send a direct employee as a qualified technical representative to the project site, during the initial installation and when requested, for the purpose of training appropriate installer personnel in proper selection and installation procedures and for rendering advice concerning the proper installation of materials.
- C. Engineered Judgements: Engineering Judgments shall not be permitted without approval, prior to permit issuance for scope of work. An Alternate Materials and Methods Request (AMMR) will be required if a listed design is not available for a specific condition.
- D. Installer Qualifications:
 1. Coordinate with mechanical, electrical, and drywaller to provide single company for installation for all firestopping materials
 2. Company specializing in installation of firestopping specified with experience on at least five projects of similar nature in past three years.
 3. Trained and approved by manufacturer of firestop materials.
 4. Engage experienced installer who is certified, licensed, FM Approved in accordance with FM 4991, Certified by UL as a Qualified Contractor, or otherwise qualified by the firestopping manufacturer (not by distributor) as having been provided the necessary training to install firestop products per specified requirements.

5. Pre-form Firestop Devices: Alternative to FM4991 and UL Certification, Furnish manufacturer installer training (not by distributor) for installation of Preformed Firestop Devices.
 6. The certified installer shall have in such person's possession a certification card available at all times during installation and inspection. Any new certified installer shall be submitted for review and approval.
- E. Installer Responsibility: Select firestop, fire containment, and fire-resistant construction joint products from those indicated for each penetration.
1. Obtain approval of authorities having jurisdiction for selected methods.
 2. Submit proposed methods along with proof of acceptance by authority having jurisdiction.
- F. Regulatory Requirements: Ensure firestop, fire containment, and construction joint components comply with applicable portions of local, state, and federal codes, laws, and ordinances for flame spread and smoke developed indices.
- G. Certifications:
1. Contractor's and installer's certification that products are installed in accordance with Contract Documents, based on inspection and testing specified as part of Field Quality Control.
 2. Manufacturer certification ensuring firestopping interface compatibility with other firestopping and systems
 3. Certificates of compliance from authority having jurisdiction indicating approval of firestops, fire containments, and construction joints.
 4. Certificate of inspection and acceptance by authority having jurisdiction of firestops, fire containments, and construction joints.

1.6 PRE-INSTALLATION CONFERENCE

- A. Conduct pre-installation conference in accordance with Section 01 31 19.
- B. Agenda: Include discussion and agreement upon acceptable:
1. Product and classification schedule.
 2. Test firestop materials to confirm compatibility with adjacent materials and chemicals and solvents with which they may come into contact during construction.
 3. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
 4. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.
 5. Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector.
 6. Coordinate with firestop manufacturer during pre-installation conference to ensure installation is completed per the required design.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00.
 - 1. Packing, Shipping, Handling, and Unloading: Deliver materials in manufacturer's unopened containers with manufacturers name, product identification, lot number, UL labels or labels of other nationally recognized independent testing agency, and mixing and installation instructions.
 - 2. Storage and Protection: Store materials to prevent deterioration and damage due to moisture, temperature change, and contamination.

1.8 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Comply with manufacturer's temperature and humidity limitations before, during, and after installation.
 - 2. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
 - 3. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
 - 4. Comply with ventilation requirements.

2.0 SEQUENCING

- B. Sequence Work properly with adjacent work to allow unobstructed access to all areas needing firestops and smoke seals.
 - 1. Identify penetrations and openings requiring firestops, smoke seals, fire containments, and construction joints.
 - 2. Schedule installation of firestopping after completion of work involving penetrating items, but prior to covering, concealing, and eliminating access to penetrations.
 - 3. Coordinate with work of other trades
- C. Inspection: Request inspection of firestops by authority having jurisdiction and testing consultant before concealment.
 - 1. Sequence work to permit installation to be inspected and approved prior to being concealed.
 - 2. Ensure that subsequent openings and penetrations are reported, properly firestopped, and inspected.

PART 2- PRODUCTS

2.1 FIRESTOPPING DEVICE AND SYSTEM MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. **Basis of Design: Hilti Corp., Tulsa, OK.**
 - 2. Specified Technologies Inc., Sommerville, NJ.
 - 3. 3M Fire Protection Products, St. Paul, MN

- B. Substitutions: Product substitutions must comply with Section 012500. Approval must be obtained by Cal Poly Facilities Planning and Capital Projects department and authority having jurisdiction for approved equivalent prior to installation.

2.2 PRODUCT DESCRIPTION

- A.
1. Intumescent sealants: intumescent, water-based sealant. Fast drying, paintable, red in color. Sealant materials for use with non-combustible and combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe. Provides a W-rating once cured
 2. Acrylic Based Firestop Sealants: Single part, water based. Paintable, low shrinkage, low VOC sealant. Use to firestop pipe penetrations (not for use with CPVC) and joints. Available in red, white and grey color.
 3. Silicone Sealants: Flexible, Smoke, fume water and UV resistant sealant. Halogen and solvent free. Meets Class 1 W-rating requirements. Use in mechanical, electrical and plumbing applications to firestop through fire rated wall and floor assemblies
 4. Self-Leveling Sealants: Products: Single part, self-leveling firestop silicone sealant. Gray in color. Meets Class 1 W-rating requirements. For use with floor penetrations UL Water leakage test.
 5. Intumescent Composite Sheets: Intumescent sheet that fastens directly to the surface, #304 stainless steel, and nonmagnetic. For use with large wall and floor fire-rated assemblies.
 6. Intumescent Collar: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item, latch mechanism for closing, BS and UL compliant, and FM approved firestop collar.
 7. Intumescent Wrap Strips: Firestop wrap device that attaches to assembly around combustible plastic pipe (closed and open piping systems) and can be continuously wrapped.
 8. Intumescent Firestop Blocks: Intumescent, re-usable, Re-enterable non-hardening blocks with an embedded fiberglass mesh used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways. To be installed with manufacturers label intact on block for ease of installation.

9. Intumescent Moldable Putty: Remains pliable, flexible and easily re-enterable, non-toxic putty. Versatile putty for pipes, cables, cable tray, blank opening and other penetrations.
10. Cast-In Place Device: A one-step cast-in firestop device for sealing combustible and non-combustible penetrations, ready-to-use out of the package, integrated moisture and smoke seal. Available in red or black.
 - a. Metal Deck Device: Cast-in firestop device that can work in composite W3 and W2 floor decks, does not require steel deck reinforcement or additional shoring and tested in accordance with UL 1479, ASTM E 814 and ASTM G21.
11. Plugs: For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected.
12. Cable pathway devices: whenever single and/or bundled low-voltage cables penetrate fire rated concrete, masonry and drywall walls and floors, where frequent cable additions and changes may occur. The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The device shall be capable of being easily ganged together. The fire-rated cable management device shall consist of a bare metal housing and frame(s) to enable grounding for electrical continuity. The device shall provide airflow containment sufficient to achieve the L-Rating requirements of the barrier type.
 - a. Round fire-rated cable management device: The device shall consist of a corrugated steel tube with zinc coating, contain and inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The device shall contain a smoke seal fabric membrane or intumescent firestop sufficient to achieve the L-Rating. Install device per the manufacturer's published installation instructions.
 - b. Rectangular fire-rated cable management device: The device shall consist of a rectangular galvanized steel sleeve with a symmetrical half-shell design for retrofit capabilities. The device shall consist of an inner and outer layer of brushes on both ends of the device sufficient to achieve the L-Rating. The device shall be capable of being easily ganged together using gang plate or floor grid systems with ganging clips. Install device per the manufacturer's published installation instructions.
13. Pre-formed Head of Wall Device: One-piece, pre-formed, polyurethane foam based, firestop seal for use with standard head-joint top tracks and slip-type head joints in fire-rated construction at top of partition to maintain continuity of the fire-

resistance-rated assembly indicated. Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle-over the top track.

14. Firestop Joint Spray: Tested in accordance with ASTM D6904, both sprayable and brushable, contains no halogens, solvents, or asbestos, mold and mildew resistance rating of 1. For use of sealing wall and top-of-wall openings and joints, building perimeter gaps between floor slabs and exterior façades.
 15. Edge of Slab Device: Pre-formed polyurethane foam based material for use as part of a perimeter fire barrier between fire resistance rated floors and exterior wall assemblies.
- B. Performance Criteria:
1. Provide products that upon curing, do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
 2. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
 3. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.
 4. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re- enterable products specifically designed for retrofit.
Systems: Comply with code for firestopping systems for each condition encountered.
- C. **INS-07** Safing Insulation, Foil Faced:
1. General: Mineral fiber composition, foil faced.
 2. Classification:
 - a. ASTM C612, Class 1 or 2.
 - b. ASTM C665: Type III, Class A.
 3. Density and Thickness: Manufacturers recommended to achieve indicated fire rating.
 4. Combustion Characteristics: ASTM E136, noncombustible.
 5. Fire rating: ASTM E84, flame spread 25 or less and smoke development 10 or less.
 6. Acceptable Products:
 - a. Owens Corning Thermafiber: Thermafiber Safing Insulation.
 - b. Roxul SAFE, Rockwool.
 - c. Or equal.
- D. Accessories: Provide accessories required by manufacturer, UL or other testing agency, and classification for specific application.
1. Sealant Primers: As instructed by manufacturer.
 2. Sealant Damming Materials:

- a. Non-combustible.
 - b. Chemically compatible with sealant.
 - c. Mineral fiberboard, mineral fiber matting, or fibrous fire safing.
3. Cleaning Solvents: As instructed by manufacturer.
4. Labels:
 - a. Provide label for each firestop condition.
 - b. Type information in non-fading ink on 20 pound (minimum) paper.
 - c. Include following information on each label:
 - 1) Manufacturer's name.
 - 2) Product name.
 - 3) Product type (sealant, putty, mortar, or other generic material description).
 - 4) F-Rating.
 - 5) W Rating.
 - 6) T-Rating. State when not required for condition.
 - 7) Testing and listing agency filing number, such as UL System number.
- E. Select adhesives, primers and sealants meeting Cal-GREEN requirements.
 1. Adhesives shall comply with VOC and chemical component limits of Cal-GREEN Table 5.504.4.1 Adhesive VOC Limit requirements.
 2. Sealants and Sealant Primers shall comply with VOC and chemical component limits of Cal-GREEN Table 5.504.4.2 Sealant VOC Limit requirements.

PART 3- EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with work when substrate conditions are acceptable.
- B. Verify that permanent penetration items have been installed and that temporary penetrating items have been removed.
- C. Verify that supports have been installed on both sides of penetrated construction as required by UL classifications.
- D. Inspect and verify that surfaces and condition of openings have no defects that could interfere with installation and performance of firestop materials.
- E. Verify sleeves installed under plumbing, mechanical, and electrical work are properly installed.

3.2 PREPARATION

- A. Clean surfaces of opening substrates free of dirt, oil, grease, loose and harmful materials which may adversely affect bond of materials to surfaces in accordance with manufacturers recommendations.
- B. Test surfaces which have been previously painted, sealed, and treated with other coatings and compounds to ensure compatibility with materials and proper bond

capability.

- C. Remove incompatible coatings and materials which may affect firestop bond with surrounding surfaces.
- D. Mask and protect adjacent surfaces from damage.
- E. Prime surfaces as instructed by manufacturer.

3.3 FIRESTOPPING INSTALLATION

- A. General: Install in accordance with manufacturer's details, applicable codes, UL or other testing agency classification requirements, and approved schedule and shop drawings.
 - 1. Fire resistant systems without UL or other testing agency classification requirements shall be approved by authorities having jurisdiction before installation.
 - 2. Install firestopping material in manner required to achieve F rating, W rating, and T rating required by UL classification, applicable codes, and authorities having jurisdiction.
 - 3. Install firestopping material with sufficient pressure to ensure uniform density and texture, and to ensure proper filling and sealing of openings to create smoke seal.
 - 4. Install forms and supports to arrest liquid and flowable material leakage and retain materials in openings.
 - 5. Remove form materials after firestopping material has cured unless materials used are permitted or required to remain according to test classifications.
- B. Through Penetration Firestopping Systems: Comply with classification design requirements. Separate cables not in conduit and maintain required separation of penetrating items from edges of openings and from each other.
 - 1. Tool and trowel exposed surfaces to smooth finish, flush with surrounding surfaces unless otherwise required by test classification.
 - 2. Remove excess firestop material promptly as work progresses.
- C. Through Penetration Firestopping:
 - 1. Securely attach device frames to supporting construction.
 - 2. Assemble component parts to ensure proper contact and sealing of gaps and openings around penetrating items.
- D. Curtain Wall Fire Containment, Foil Faced Safing Insulation:
 - 1. Fill voids between curtain wall and edge of slabs at floors and roofs in accordance with manufacturer's instructions. Do not leave voids in safing.
 - 2. Tape and seal tears and cuts in facing.
 - 3. Seal joints with manufacturer's recommended sealant.
 - 4. Provide flexible fire rated smoke seal tested and approved for dynamic movement.
 - 5. Create fire rated assembly with UL design number.
- E. Fire Resistant Construction Joints:
 - 1. Provide fire resistant systems to match fire rating of adjacent construction.

2. Provide fire resistant systems at following locations:
 - a. Voids and gaps in fire rated construction, including control joints and gap at top of fire-rated CMU walls.
 - b. Fire rated partition and metal deck flutes.
 - c. Changes in partition material.
 - d. Floor joints not requiring expansion joint.
 - e. Other locations indicated and required by applicable codes.

3.4 FIELD QUALITY CONTROL

- A. Site Inspections: Comply with Division 01 requirements.
- B. Inspection: Owner may engage and pay for services of independent testing consultant to perform quality control inspection.
- C. Do not conceal firestops, fire containments, and fire resistant construction joints prior to required inspection by Inspector of Record (IOR) and authority having jurisdiction (AHJ)
- D. Notify authority having jurisdiction and designated inspectors of work released for inspection.
- E. Manufacturer's Field Service: At the start of the installation, periodically as the Work progresses, and after completion, utilize the firestop material manufacturers' representative at the job site as necessary to advise on every phase of the Work.
- F. Listed documentation shall be provided by the Contractor or Subcontractor during inspections in accordance with 014100. Listed documentation shall be by the listing agency, not the manufacturer.
- G. Labels:
 1. Provide label for each firestop/smoke seal condition.
 2. Securely fasten label immediately adjacent to firestopping condition to allow authorities having jurisdiction and owner's inspection agency to readily identify and confirm system.
 3. Wall partitions are required to have protected openings or penetrations permanently identified with signs or stenciling. Such identification shall be located in accessible concealed floor, floor-ceiling or *attic* spaces:
 - a. Be located within 15 feet of the end of each wall and at intervals not exceeding 30 feet measured horizontally along the wall partition and
 - b. Include lettering not less than 3 inches height with a minimum 3/4 inch stroke in a contrasting color incorporating the suggested wording. "**Fire and/or smoke barrier- protect all openings**" or similar wording.
- H. Inspection Requirements:
 1. Visually examine firestopping, fire containments, and fire resistant construction joints to verify compliance with Contract Documents.
 2. Examine firestopping, fire containments, and fire resistant construction joints for proper installation, adhesion, and curing appropriate for each material.
 3. Submit written inspection report including following information:

- a. Identify construction penetrated including fire resistance rating.
 - b. Identify penetrating item.
 - c. Identify products and manufacturers included in each system.
 - d. Identify form material used.
 - e. Firestop classification and description from UL, FM, Warnock Hersey or other independent testing agency.
 - f. Fire containment and fire resistant construction joint description.
 - g. F, T, and W rating.
 - h. State whether firestop, fire containment, and fire resistant construction joint is or is not in full compliance with testing agency classification, description and manufacturer's requirements. If variations occur confirm acceptance of variation by manufacturer and authority having jurisdiction.
- I. Re-examine firestopping, fire containments, and fire resistant construction joints immediately prior to concealment by other construction to ensure no damage has occurred since initial inspection.
 - J. Correct unacceptable firestopping, fire containments, and fire resistant construction joints, and provide additional inspection, to verify compliance with this Section, at no additional cost to Owner.

3.5 REPAIRS AND MODIFICATIONS

- A. Identify damaged and re-entered seals requiring repair and modification.
- B. Remove loose and damaged materials.
- C. If penetrating items are to be added, remove enough material to permit penetration by new elements, being careful not to damage balance of seal.
- D. Repair holes, cracks, and damage in accordance with manufacturer's instructions to ensure complete smoke seal.
- E. Use only materials approved by manufacturer of original seal as suitable for repair.

3.6 CLEANING

- A. General:
 1. Clean as instructed by manufacturer. Do not use materials or methods which may damage firestop or surrounding construction.
 2. Remove stains and correct damage to adjacent surfaces.

3.7 PROTECTION

- A. Protect material subject to traffic from damage.

END OF SECTION 07 84 00

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes joint sealants.
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Silyl-terminated polyether joint sealants.
 - 4. Butyl joint sealants.
 - 5. Latex joint sealants.
- B. Related Sections include the following:
 - 1. Division 8 Section "Glazing" for glazing sealants.
 - 2. Division 9 Section "Gypsum Board" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- 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 4-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint material location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.
- E. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- F. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.
- G. Qualification Data: For Installer.
- H. Compatibility and Adhesion 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 needed for adhesion.
- I. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.
- J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- C. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Adhesives, sealants and caulks shall meet the following requirements of the following standards:
 - 1. Adhesives, adhesive bonding primers, adhesive primers, Sealants, sealant primers and caulks shall comply with local or regional air pollution control or air quality management district rules as applicable or SCAQMD Rule 1168 VOC limits as shown on tables 5.504.4.1 and 5.504.4.2. Such products shall also comply with rule 1168 prohibition on the use of certain toxic compounds (chloroform, ethylene dichloride, methylene chloride, perchloroethylene and trichloroethylene) except aerosol products as specified in subsection 2 noted below.
 - 2. Aerosol adhesives and smaller unit sizes of adhesives and sealant or caulking compounds (in units, less packaging, which do not weigh more than one pound and do not consist of more than 16 fluid ounces) shall comply with statewide VOC standards and other requirements, including prohibitions on the use of certain toxic compounds, of California Code of Regulations, Title 17, commencing with section 94507.

1.7 PROJECT 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. Notify Architect/ Inspector of the non-compliant condition.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: 5 years (20 years for Silicone Sealants) from the date of Final Completion.
- B. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within the specified warranty period.
 1. Warranty Period: 2 years from Final Completion.
- C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Joint Sealants: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 1. Dow Corning Corp.
 2. Pecora Corporation.
 3. United States Gypsum Co

4. Tremco, Inc.
5. Bostik Construction Products Division
6. General Electric Sealants
7. WR Meadows
8. Or equal. (Reference substitution requirements in Division 1 Section)

2.2 MATERIALS, GENERAL

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.
- C. 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 sealant manufacturer, based on testing and field experience.
- D. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.
- F. Low-Emitting Interior Sealants: Sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 JOINT SEALANTS

- A. Type A - Acrylic Latex: One-part, non-sag, mildew resistant acrylic emulsion compound complying with ASTM C834, Type OP, Grade NF, formulated to be paintable.

1. Tremco Inc., "Tremflex 834"
 2. Bostik Construction Products Division, "Chem-Calk 11200".
 3. Pecora Corporation, "AC-20"
- B. Type B - Butyl Sealant: One-part, non-sag solvent-release-curing sealant complying with ASTM 1311 and formulated with a minimum of 75 percent solids.
1. Tremco Inc., Tremco "Bitul Sealant"
 2. Bostik Construction Products Division, "Chem-Calk 300".
 3. Pecora Corporation, "BC-158".
- C. Type C - Silicone Sealant: One-part nonacid-curing silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25.
1. Dow Corning Corp., "Dow Corning 791".
 2. General Electric Co., "SCS 2000 Silpruf".
 3. Pecora Corp., "890FTS"
- D. Type D - Neutral-Curing Silicone Sealant: One part medium modulus neutral-curing silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25.
1. Dow Corning Corp., "Dow Corning 899".
 2. General Electric Co., "SSG 4000AC Ultraglaze".
 3. Tremco, Inc., "Spectrum 3".
 4. Pecora Corp., "895NST".
- E. Type E - One-Part Mildew-Resistant Silicone Sealant: Complying with ASTM C920, Type S, Grade NS, Class 25.
1. Dow Corning Corp., "Dow Corning 791".
 2. General Electric Co., "SCS 1700 Sanitary".
 5. Tremco, Inc., "Proglaze" (White)
 6. Pecora Corp., "860" or "894NST" (White).
- F. Type F - Multi-Part Pourable Sealant: Complying with ASTM C920, Type M, Grade P, Class 25. Shore A hardness +40.
1. Tremco, Inc., "Vulkem 45SSL".
 2. Pecora Corp., "Dynatred" or "Urexpan NR-200".
 3. W.R. Meadows, "Pourthane SL".
- G. Type G - Acoustical Sealant: Nondrying, nonhardening permanently flexible conforming to ASTM D217.
1. Pecora Corp., "BA-98 Acoustical Sealant"
 2. Tremco, Inc., "Tremco Acoustical Sealant".
 3. United States Gypsum Co., "Sheetrock Acoustical Sealant".

- H. Type H - Sound and Fire Protective Rated Moldable Putty Pads as wall opening protective materials when code required in fire-rated walls.
 - 1. Reference Specification Section 07 84 16

2.4 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, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
- D. Joint Backing: ASTM D1056; round, closed cell polyethylene foam rod; oversized 30 to 50 percent larger than joint width
- E. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with manufacturers and document requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Beginning of installation means installer accepts existing substrate.

3.2 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 all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include examples of the following:
 - a. Asphalt
 - b. Concrete.
 - c. Exterior Cement Plaster
- B. Remove laitance and form-release agents from concrete.
 - 1. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include examples of the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
- C. Verify that joint backing and release tapes are compatible with sealant.
- D. Perform preparation in accordance with ASTM C1193.
- E. Protect elements surrounding the Work of this Section from damage or disfiguration
Joint Priming:
- F. Prime joint substrates, where recommended in written form by joint-sealant manufacturer, based on 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.

- G. Joint Priming: Prime joint substrates, where recommended in written form by joint-sealant manufacturer, based on 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
- H. Masking Tape: Use masking tape where required to prevent contact of sealant 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.

3.3 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 C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Install sealant backings of type 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.
- E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- F. 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.
- G. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified 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 C 1193 unless otherwise indicated.
 4. Provide flush joint profile according to Figure 8B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth according to Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- H. Installation of Preformed Tapes: Install according to manufacturer's written instructions.
- I. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant 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.
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant 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.
- J. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 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.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT LOCATION SCHEDULE

SCHEDULE

Type	Location	Color
Type A - Acrylic Latex Cure	All interior joints not otherwise scheduled	To match adjacent surfaces
Type B - Butyl	Under thresholds	Black
Type C - One-Part Nonacid Curing Silicone	Exterior door, entrance & window frames	Bronze
Type D - Neutral-Curing Silicone	Joints within glass and glazing	Translucent
Type E - Mildew-Resistant Silicone	Interior joints in ceramic tile and at plumbing fixtures	White
Type F - Sound and Fire Protective Rated Moldable Putty Pads	At fire-rated wall openings when code required, such as electric boxes. In sound rated walls at electric boxes.	Red

END OF SECTION 07 92 00

SECTION 08 11 00 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Standard hollow metal doors and frames.
- B. Related Sections
 - 1. Division 7 Section "Flexible Sheet Flashing" for flashing windows, door, and other openings.
 - 2. Division 8 Section "Door Hardware" for door hardware for hollow metal doors.
 - 3. Division 8 Section "Glazing" for glazing requirements.
 - 4. Division 9 Section "Painting" for field painting hollow metal doors and frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
- B. Other Action Submittals:
 - 1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference designation for details and openings as those on Drawings. Coordinate with door hardware schedule.

- a. Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - b. Indicated specific model number of door and frame.
 - c. Indicate steel sheet type (galvanized, non-galvanized, etc.)
 - d. Indicate door and frame type (A, A1, B, C, etc.)
 - e. Indicated hardware group.
 - f. Indicate dimensions and locations of mortises and holes for hardware.
 - g. Indicate dimensions and locations of cutouts.
 - h. Indicate fire ratings for fire doors.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

- A. Reference Standards:
1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 6. 2019 California Energy Code, Part 6, Title 24 CCR
 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- C. 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 positive pressure according to UL-10C.
1. Temperature-Rise Limit: Where required, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure per UBC 7-2.
- D. Smoke-Control Door Assemblies: Comply with UBC Standard 7-2.

- E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
 - 1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages 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.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel doors and frames that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 years.

- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Steel Doors and Frames: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Steelcraft; an Ingersoll-Rand company. (Basis of Design)
 - 2. Ceco Door Products; an Assa Abloy Group company.
 - 3. Curries Company; an Assa Abloy Group company.
 - 4. Or equal (Reference substitution requirements in Division 1 Section)

2.2 MATERIALS

- A. Galvanized (Metallic-Coated) Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with minimum A60 metallic coating for exterior doors and frames.
- B. Frame Anchors: ASTM A 591, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008 or ASTM A 1011, hot-dip galvanized according to ASTM A 153, Class B.
- C. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153.
- D. Powder-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.
- E. Glazing: Comply with requirements in Division 8 Section "Glazing."
 - 1. Wired glass is not allowed.
 - 2. Tempered or fire-rated where required.

2.3 STANDARD HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
 - 1. Design: Flush panel.
 - 2. Gauge: 16GA

3. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - a. Fire Door Core: As required to provide fire-protection indicated.
 4. Vertical Edges for Single-Acting Doors: Beveled edge.
 - a. Beveled Edge: 1/8 inch in 2 inches.
 5. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
 6. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.
 7. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
 8. Vision, Narrow Lite, Half Glass Doors: Size as indicated on Drawings.
- B. Exterior Doors: Face sheets fabricated from galvanized (metallic-coated) steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush):
 - a. Face thickness: 16 gage (0.053 inch).
 - 1) Product: Series L16 by Steelcraft. (Basis of Design)
 - 2) Or Approved Equal.
- C. Interior Doors: Face sheets fabricated from galvanized (metallic-coated) steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush):
 - a. Face thickness: 18 gage (0.053 inch).
 - 1) Product: Series L16 by Steelcraft. (Basis of Design)
 - 2) Or Approved Equal.
- D.
- E. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- ## 2.4 HOLLOW METAL FRAMES
- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Exterior and Interior Door Frames: Fabricated from metallic-coated steel sheet.
1. Fabricate door frames with mitered or coped corners.
 2. Fabricate door frames as full profile welded unless otherwise indicated.
 3. Exterior Frame: 14 gage (0.067-inch) thick steel sheet.

- a. Product: F14 Series by Steelcraft.
- b. Or Approved Equal.
4. Interior Frame: 16 GA knock-down type.
5. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME COMPONENT REQUIREMENTS:

- A. Fabricate frame assemblies from three basic components:
 1. Open Sections (perimeter members) identical in configuration to standard frames.
 2. Closed sections (intermediate members) with identical jamb depth, face dimensions, and stops as open sections.
 3. Sill sections: Fabricated from galvanized steel, flush with both faces of adjacent vertical members. Cut individual components to length and notched to assure square joints and corners.
- B. Externally welded face joints at meeting mullions or between mullions and other frame members on the face surfaces only. Grind and finish face joints smooth.
- C. Fabricate frame assemblies for shipment to the jobsite completely welded.
 1. Field joints permissible only when the size of the total assembly exceeds shipping limitations.
 2. Fabricate oversized frames in sections designated for splicing in the field.
 3. Provide frames with joint reinforcements 14 gage (1.7 mm), 8 inches (203 mm) long.
 4. Field weld joint reinforcement inside and tack weld outside joint at both faces, grind, and finish smooth and uniform in appearance, after installation.
- D. Pierced and dimpled glazing beads for use with manufacturers' standard fasteners.
- E. Provide necessary anchors for jambs, heads, and sills of assemblies.
- F. Verify field dimensions as required. Do not begin fabrication until these dimensions have been verified, and approved.

2.6 ACCESSORIES:

- A. Glazing Bead: Formed steel sheet; screw-attached.
 1. Glazing Bead: Formed steel sheet; snap-in installation.

2.7 FIRE RATING

- A. Provide factory assembled welded units bearing Labels for fire ratings indicated on the Drawings.

2.8 FINISH

- A. Factory prime finish in accordance with ANSI A 250.10.

2.9 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fastener.

2.12 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
- C. Loose Stops for glazed lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.13 LOUVERS

- A. Provide louvers for doors, where indicated, that comply with SDI 111C.
- B. Inserted Louver: (non-fire rated)
 - a. 18 gage steel, welded to fabricated sub-frame.
 - b. 1-inch-thick, inverted "Y" blade type, inserted into opening prepared in door faces.
 - c. Free air space: 50% of louver area.
 - d. Product: L-219 (24 by 24 inches) by Steelcraft. (Basis of design)
 - e. Or Approved Equal

2.14 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- wide steel.
- C. Provide Screw-In Top Cap for exterior doors.

2.15 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances:
 - a. Standard doors and frames: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
 - 3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Transom Bar 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 butt welding.
 - 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - b. Three anchors per jamb up to 60 inches high.
 - c. Four anchors per jamb from 60 to 90 inches high.
 - d. Five anchors per jamb from 90 to 96 inches high.
 - e. Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - f. Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
 - g. Compression Type: Not less than two anchors in each jamb.
 - h. Post installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
7. Door Silencers: Except on weather-stripped doors, 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.
- E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."
 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
- G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 4. Provide loose stops and moldings on inside of hollow metal work.

5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

H. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.

1. Maximum Rate: 0.3 cfm/sq. ft. of area at an inward test pressure of 1.57 lbf/sq. ft.

2.16 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Field-Applied Paint Finish: Comply with Division 9 Section "Painting".

3 EXECUTION

3.1 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 roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

- C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - 2. At fire-protection-rated openings, install frames according to NFPA 80.
 - 3. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - 4. Install frames with removable glazing stops located on secure side of opening.
 - 5. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - 6. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - 7. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post installed expansion anchors.
 - 8. Floor anchors may be set with powder-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
 - 9. In-Place Gypsum Board Partitions: Secure frames in place with post-installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

10. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
 11. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 12. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 13. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 14. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 15. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 2. Fire-Rated Doors:
 - a. Install doors with clearances according to NFPA 80.
 - b. Smoke-Control Doors: Install doors according to UBC Standard 7-2.
- D. Glazing: Comply with installation requirements in Division 8 Section "Glazing" and with hollow metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.

- C. 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.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 11 00

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SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wood doors, non-rated.
- B. Glass lite frames.
- C. Door louvers.

1.2 REFERENCES

- A. WDMA I.S.1 - Industry Standard for Wood Flush Doors (Includes Standards I.S.1.1 through I.S.1.7).
- B. NFPA 80 - Fire Doors and Windows.
- C. UBC - Uniform Building Code.
- D. UL 10C - Fire Tests of Door Assemblies.
- E. WI - Woodwork Institute: Manual of Millwork.
- F. Reference Standards
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

1.3 QUALITY ASSURANCE

- A. Conform to requirements of WI Manual of Millwork, Section 12 and 13, Premium (P) Grade except where otherwise indicated.
- B. Issue a WI Certified Compliance Certificate prior to delivery of doors certifying that doors meet all requirements of WI Grade specified.
- C. After completion issue a WI Certified Compliance Certificate for Installation.

1.4 REGULATORY REQUIREMENTS

- A. Conform to 2019 CBC for fire-rated doors.
- B. Fire Door Construction: Conform to UL 10C.
- C. Installed Doors: Conform to NFPA 80 for fire-rated class indicated on Drawings.

1.5 SUBMITTALS

- A. Submit under provisions of Division 1 Section.
- B. Shop Drawings shall bear the WI Certified Compliance Label on the first page of each set. Indicate door elevations, stile and rail reinforcement, internal blocking for hardware attachment, and cutouts for glazing and louvers.
- C. Submit two Samples 12 inches x 12 inches in size illustrating each species and finish specified.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Package, deliver, and store doors in accordance with WI requirements as set forth in Technical Bulletin 419-R.

1.7 WARRANTY

- A. Provide manufacturer's standard lifetime warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS, FLUSH FACED DOORS and FRAMES

- A. Eggers Industries, Inc.
- B. Marshfield Door Systems, Inc.
- C. Algoma Hardwoods, Inc.
- D. Frames: Anemostat
- E. Or approved equal (Under provisions of Division 1 Section)

2.2 DOOR AND FRAME CONSTRUCTION

- A. Solid Non-rated Core: Solid wood block, framed block glued, or solid particleboard.
- B. Solid, Special Function Core: Labeled fire performance type.
- C. Construction: 5-ply, with face veneer applied vertically over wood veneer cross banding.
- D. Flush Interior Door Veneer: Birch for paint grade and species to match adjacent wood or simulated wood finishes. Satin sheen. Color as selected by Architect to match other doors on site.

2.3 GLASS LITE FRAMES

- A. 20 Ga. Cold rolled steel

2.4 ADHESIVES

- A. Exterior and Interior Doors: WI Type I.

2.5 FABRICATION

- A. Fabricate non-rated wood doors to requirements of WI Manual of Millwork, Section 12 and 13, in the WI Grade specified.

- B. Fabricate fire rated doors per manufacturer's standard construction, and labeling agency requirements.
- C. Pre-machine doors for finish hardware.
- D. For fire rated doors with mineral cores, provide solid wood blocks for hardware reinforcement at lock edge, mid-height push bar, and at top of door for closer.
- E. For fire-rated doors with mineral cores, provide solid wood blocking for thru-bolted hardware.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install doors in accordance with WI Manual of Millwork Sections 12 and 13 and WI Technical Bulletin 420-R. Conform to WI requirements for fit tolerances.
- B. Coordinate installation of glass and glazing.
- C. Install door louvers.
- D. Adjust doors for smooth and balanced movements.
- E. Install fire doors in accordance with NFPA 80.

3.2 INSTALLATION TOLERANCES

- A. Edge clearance for swinging doors shall not exceed the following:
 - 1. Between door and frame at head and jamb
 - a. 1/8 inch
 - 2. Between edge of pair of doors
 - a. 1/8 inch
 - 3. At door sill with threshold
 - a. 3/8 inch
 - 4. At door bottom and surface of nominal floor covering per NFPA 80 and at doors requiring an undercut as indicated on Drawings.
 - a. 5/8 inch

- B. Frame installation tolerance shall not exceed the following:
1. Squareness $\pm 1/16$ inch
 2. Alignment $\pm 1/16$ inch
 3. Plumbness $\pm 1/16$ inch
 4. Diagonal Distortion $\pm 1/32$ inch

END OF SECTION 08 14 16

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SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Access doors and frames for walls and ceilings.
- B. Related Sections include the following:
 - 1. Division 8 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
 - 2. Division 9 Section "Painting" for field applied finishes.

1.3 SUBMITTALS

- A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.
- D. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.4 QUALITY ASSURANCE

- 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
- 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
- 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
- 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR

5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations
11. NFPA 72 - National Fire Alarm and Signaling Code (California Amended) 2016 Edition (Note: See UL Standard 1971 for "Visual Devices").
12. NFPA 80 - Fire Door and Other Opening Protectives, 2016 Edition.
13. NFPA 101- Life Safety Code. 2015 Edition

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Source Limitations: Obtain each type of access door(s) and frame(s) through one source from a single manufacturer.
- C. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 1. NFPA 252 or UL 10B for vertical access doors and frames.
 2. ASTM E 119 or UL 263 for horizontal access doors and frames.
- D. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work, and indicate in the schedule specified in "Submittals" Article.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of access doors and frames that fails in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 2 years.

B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Access Doors and Frames: Subject to compliance with requirements, provide products by one of the following:
1. Acudor.
 2. Milcor Inc.
 3. Nystrom, Inc.
 4. Karp Associates Inc.
 5. Or equal (Reference substitution requirements in Division 01)

2.2 STEEL MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
1. ASTM A 123, for galvanizing steel and iron products.
 2. ASTM A 153, for galvanizing steel and iron hardware.
- B. Steel Sheet: Cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.
- C. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Factory Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Field Finish: Factory prime for field painting as specified in Division 9 "Painting".
- D. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

2.3 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Acudor UF-5000 non-fire-rated access door and frame:

1. Size: As indicated on Drawings or as required for access.
2. Material: 16 gage door, 16 gage mounting frame.
3. Door: Flush to frame - rounded safety corners.
4. Frame: One-piece outer frame welded to mounting frame.
5. Hinge: Continuous, concealed.
6. Latch: Cylinder lock and key.
7. Factory Finish: 5-stage iron phosphate preparation with prime coat of gray.
8. Field Finish: Comply with Division 9 Section "Painting".

B. Acudor FB-5060 fire-rated access door and frame:

1. Size: As indicated on Drawings or as required for access.
2. Material: Steel 16 gage door, 16 gage mounting frame.
3. Door: Flush to frame with reinforced edges.
4. Frame: Flanged to be 1" wide, mounting frame to have anchor straps.
5. Hinge: Concealed.
6. Fire Rating: UL - 1-1/2 hour "B" label.
7. Latch: Master keying - rim cylinder locks.
8. Factory Finish: 5-stage iron phosphate preparation with prime coat of gray.
9. Field Finish: Comply with Division 9 Section "Painting".

2.4 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 panels to types of supports indicated.
1. Exposed Flanges: Nominal 1 to 1-1/2 inches wide around perimeter of frame.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
1. For cylinder lock, furnish two keys per lock and key all locks alike.

PART 3 - EXECUTION

3.1 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.

3.2 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

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SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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. Aluminum doors, frames and glazed lights.
 - 2. Anchors, brackets, and attachments.
 - 3. Perimeter sealants.
- B. Related Sections:
 - 1. Division 08 Section "Glazing" for glass and glazing

PART 2 - REFERENCES

2.1 STANDARDS

- A. Contractor's work shall comply with the following standards as applicable. Manufactured items are to be fabricated to these same standards.
- B. The following standards (and publications) are applicable to the extent referenced in the text.
 - 1. The most recent of these standards is implied, unless otherwise stated.
 - 2. ASTM A36 - Structural Steel.
 - 3. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
 - 4. ASTM E283 - Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors.
 - 5. ASTM D2000 - Classification System for Rubber Products.
 - 6. ASTM D2287 - Non-rigid Vinyl Chloride Polymer and Copolymer molding and Extrusion Compounds.
 - 7. AAMA 701.2 - Voluntary Specification for Pile Weatherstripping.
 - 8. AAMA SFM-1 - Aluminum Storefront and Entrance Manual.
 - 9. NAAMM - Metal Finishes Manual.
 - 10. CBC - California Building Code.

C. Reference Standards:

1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
1. System to provide for expansion and contraction within system components caused by a cycling temperature range of 120 F degrees without causing detrimental effects to system or components.
 2. Design and size members to withstand dead loads and live loads caused by pressure and suction of wind as calculated in accordance with CBC.
 3. Limit mullion deflection to 1/200, or flexure limit of glass with full recovery of glazing materials, whichever is less
 4. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 5. Dimensional tolerances of building frame and other adjacent construction.\
 6. Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior.
 7. Limit air infiltration through assembly to 0.06 cu ft/min/sq ft as measured in accordance with ASTM E283.
 8. System to accommodate, without damage to system or components, or deterioration of perimeter seal: Movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; and deflection of structural support framing.
 9. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.

- c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
- d. Glazing-to-glazing contact.
- e. Noise or vibration created by wind and by thermal and structural movements.
- f. Loosening or weakening of fasteners, attachments, and other components.
- g. Sealant failure.
- h. Failure of operating units.

2.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems. Submit under provisions of Division 01 Section.
- B. Shop Drawings: Include system and component dimensions; components within assembly; framed opening requirements and tolerances; anchorage and fasteners; glass and infills; sub sill-pans under storefront units, door hardware requirements; and affected related Work. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
 - 1. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Samples for Initial Finish Selection: For units with factory-applied color finishes provide samples of full range finish colors available from the manufacturer. (2' X 3" squares)
- D. Samples for Final Verification: For each type of exposed finish selected from samples, Submit two Samples of the shapes used, 12 inches long, showing prefinished aluminum surface. Panel samples to be 12" x 12"

2.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer
- B. Seismic Qualification Certificates: For aluminum-framed 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.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.

- D. Field quality-control reports.
- E. Warranties: Sample of special warranties.

2.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

2.6 QUALITY ASSURANCE

- A. Perform Work in accordance with AMA SFM-1.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. .
 - 1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- E. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
- F. Pre-installation Conference: Conduct conference at Project Site
 - 1. Convene a pre-installation conference approximately two (2) weeks before scheduled commencement of storefront system installation and associated work. All submittals shall be submitted and review completed prior to the meeting. Allow time for review and resubmission as necessary.
 - 2. Require attendance of installer of each component of associated work, installers of substrate construction to receive window system, and other work in and around window installation which must precede or follow installation work (including cement plaster, fiber cement siding, and finish carpentry work if any), window system manufacturer's representative, the IOR, and other representatives directly concerned with performance of the Work. Also, provide notification of Architect, Owner, Owner's insurers, testing agencies and governing authorities.
 - 3. Objectives of conference to include:
 - a. Review foreseeable methods and procedures related to window installation work, including set up and mobilization areas for stored material and work area.

- b. Tour representative areas of the Work, inspect and discuss condition of substrate, curbs, rough openings and other preparatory work performed by others as needed.
 - c. Review window system requirements (drawings, specifications and other contract documents).
 - d. Review and finalize construction schedule related to the window installation work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
 - e. Review required inspection, testing, certifying and material usage accounting procedures.
 - f. Record discussion of conference including decisions and agreements (or disagreements) reached. Furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference. The Owner's Representative will designate one of the conference participants to record the proceedings and promptly distribute them to the participants for record.
- G. The intent of the conference is to resolve issues affecting the installation and performance of the window installation work. Do not proceed with the installation work until such issues are resolved the satisfaction of the Owner and Engineer of Record. This shall not be construed as interference with the progress of Work on the part of the Owner or Engineer of Record.

2.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.
- B. Verify wall openings and adjoining materials are ready to receive Work of this Section.
- C. Confirm that site conditions and substrates are ready for work covered under this section to commence. If not, Contractor is to make suitable repairs or adjustments to the work.
- D. Beginning of installation means acceptance of existing conditions

2.8 DELIVERY, STORAGE AND HANDLING.

- A. Deliver, store, and handle system components under provisions of Section 01 60 00.

- B. Provide strippable coating to protect prefinished aluminum surfaces.

2.9 WARRANTY

- A. The window manufacturer shall furnish a written warranty against defects in workmanship and materials for a period of ten (10) years from the date of Substantial Completion. Warranty shall stipulate that service to windows shall be performed on job site and not at a point of manufacture. Warranty shall cover all portions and components of the system, including the laminated glass.
- B. Manufacturer shall designate the factory certified installer as responsible to be on call for a period of five (5) years following the date of Project Closeout. During such time, all calls shall be responded to within eight (8) hours of notification by the District. On call shall include any repairs required for the system and caulking, as well as training and assistance to District staff as needed.
- C. Following the five-year period and for the remainder of the ten- year warranty period, the manufacturer shall be on call to correct all defects in manufacture. If such corrections involve need for the designated factory-certified installer, then installer shall be included as well.

PART 3 - PRODUCTS

3.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide named product by the following:
 - 1. Vistawall / Old Castle FG-3000 (Basis of Design)
 - a. Vistawall Center-glazed: Storefronts.
 - b. Vistawall MS-375 Medium-Stile Doors (non-thermal)
 - 2. United States Aluminum
 - 3. Kawneer
 - 4. Or equal. Substitutions: Under provisions of Division 01 Section.

3.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Extruded Aluminum: ASTM B221; Alloy G.S. 10A-T5.
 - 2. Brackets and Reinforcements: High strength aluminum.

3. Fasteners: Stainless steel, aluminum.
4. Compression Weatherstripping: Replaceable gaskets of molded neoprene complying with ASTM D2000, or molded PVC complying with ASTM D 2287.
5. Sliding Weatherstripping: Replaceable wool, polypropylene or nylon woven pile; nylon fabric or aluminum strip backing; complying with AAMA 701.2.

B. FABRICATED COMPONENTS

1. Frames: 2 inch profile by 4 1/2 inches
2. Glazing Stops: beveled glazing strips.
3. Reinforced Mullion: Extruded aluminum cladding with internal reinforcement of steel shaped structural section as required by manufacturer.

3.3 GLASS AND GLAZING MATERIALS

- A. Glass and Glazing Materials: As specified in Section 08 80 00 and as indicated on Drawings Glazing.
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
- D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

3.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
 1. Standard Frames: 2" inch profile, flush glazing stops
 - a. Door (non-thermal):
 - 1) Medium stile: 2 inches thick (depth), 3 1/2 inch wide top and mid-rail, 3 1/2 inch wide vertical stiles, 10" inch wide bottom rail (nominal dimensions); glazing strips. All stiles and rails welded.

3.5 ENTRANCE DOOR HARDWARE

- A. Door Hardware: As specified in Division 08 Section "Door Hardware."

3.6 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Section 07 "Joint Sealants."
 - 1. Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Sealants used inside the weatherproofing system 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."
- B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

3.7 FABRICATION

- A. Fabricate doors and frames allowing for minimum clearances and shim spacing around perimeter of assembly; yet enabling installation.
- B. Rigidly fit and secure joints and corners with internal reinforcement. Weld top and bottom rails of doors to reinforcement clips. Make joints and connections flush, hairline, and weatherproof.
- C. Develop drainage holes with moisture pattern to exterior.
- D. Prepare components to receive anchor devices. Fabricate anchorage items.
- E. Arrange fasteners, attachments, and jointing to ensure concealment from view.
- F. Prepare components with internal reinforcement for door hardware and door operator hinge hardware.
- G. Reinforce framing members for imposed loads.

3.8 ALUMINUM FINISHES

- A. Color Anodic Finish: NAAMM, Class I, 0.018 mm or thicker.
 - 1. Color: Medium bronze

PART 4 - EXECUTION

4.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

4.2 INSTALLATION

- A. Install doors, frames, glazing and hardware in accordance with manufacturer's instructions and AAMA SFM-1.
- B. Use anchorage devices to securely attach frame assembly to structure.
- C. Attach to structure to permit adjustment to accommodate construction tolerances and other irregularities.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent Work.
- E. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- F. Install hardware using templates provided. Refer to Section 08 71 00 for installation requirements.
- G. Install glass in accordance with Section 08 80 00, using exterior dry method of glazing.
- H. Adjust operating hardware.
- I. Metal Protection:
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
 - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 - 3. Apply bituminous paint to separate dissimilar metals and metal surfaces in contact with cementitious or dissimilar materials.
- J. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

- K. Install glazing as specified in Section 08 "Glazing."
 - 1. Install weather seal sealant according to Section 07 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
- L. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
 - 1. 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.

4.3 FABRICATION

- A. Fabricate doors and frames allowing for minimum clearances and shim spacing around perimeter of assembly, yet enabling installation.
- B. Rigidly fit and secure joints and corners with internal reinforcement. Weld top and bottom rails of doors to reinforcement clips. Make joints and connections flush, hairline, and weatherproof.
- C. Develop drainage holes with moisture pattern to exterior.
- D. Arrange fasteners, attachments, and jointing to ensure concealment from view.
- E. Prepare components with internal reinforcement for door hardware and door operator hinge hardware.
- F. Reinforce framing members for imposed loads.
- G. Install aluminum-framed systems to comply with the following maximum erection tolerances:
 - 1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
 - 2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
- H. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

4.5 TOLERANCES

- A. Variation from Plane: 0.03 inches per foot maximum or 0.25 inches per 30 feet, whichever is less
- B. Misalignment of Two Adjoining Members Abutting in Plane: 0.015 inches maximum

4.6 ADJUSTING

- A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
 - 1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge
 - 2. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge

4.7 CLEANING

- A. Remove protective material from prefinished aluminum surfaces
- B. Wash down exposed surfaces using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer

END OF SECTION 08 41 13

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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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Door Hardware Campus Standards
 - 2. Campus Keying System
 - 3. Key Schedule Requirements

PART 2 - PRODUCTS

2.1 Keying System:

- A. University Facility Services Campus Key Coordinator designs keying system.
- B. Contractor:
 - 1. General: Submit proposed keying system to Architect for review and written approval by Trustees, and copy of Best Access (Stanley Security Solutions) Purchase Order Number to Architect for Trustees Records.
 - 2. Closeout Submittal: Submit three hard copies and one electronic copy of final keying schedule.
 - 3. Products: Key locks and cores at factory and maintain permanent records of information.
 - 4. Execution: After submittal and approval of keying system by Trustees, submit manufacturer's Purchase Order Number for Trustees to order cores and keys. Manufacturer shall deliver permanent keys, control keys and cylinder cores to Trustees Representative.
 - 5. Coordinate installation of permanent cores by University Lock Shop with Trustees Representative.

2.2 Keys:

- A. Material: Nickel-silver. Stamp keys "Do Not Duplicate."
- B. Quantity: Cylinder Keys (3 per core); and Extra Blank Keys (1 per core or lock).
- C. Keying:
 - 1. Telecommunication Spaces (Rooms): Use 112-series key lock. (Coordinate with Division 27 – Communications.)
 - 2. Master Padlocks: Use where less security is required. Coordinate with Trustees Representative during design process for specific Campus Project requirements, and Divisions 21, 22, 23, 26 (Electrical Panels), 27, and 32 (Bollards). Key alike to Campus Specifications #2359, and provide 2 keys per panel, etc.
 - 3. State Padlocks: Use where higher security is required, such as Electrical Yards and Switches, HVAC Yards and Equipment, etc. Coordinate with Trustees Representative during design process for specific Campus Project requirements, and Divisions 21, 22, 23 (HVAC Air Handling Units), 26 (Electrical Switchgear, Transformers), 27, and 32. Requires interchangeable cores complying with Campus Cylinders and Keying Standards. Interchangeable core.

2.3 Hinges:

- A. Campus Preferred Manufacturers:
 - 1. Hager Companies: Exterior -- Stainless Steel, Ball Bearing Part #BB1191; Interior – Plated with 626 Finish, #BB1279BB
 - 2. McKinney Products Company, Division of Assa Abloy
 - 3. Stanley.

2.4 Pivots and Pivot Hinges:

- A. Campus Preferred Manufacturers:
 - 1. Ives; Division of Allegion
 - 2. Rixson-Firemark, Inc.; Div. of Assa Abloy
 - 3. National Manufacturing 101 Retro Kit

2.5 Continuous Pin and Barrel Hinges:

- A. Campus Preferred Manufacturers:
 - 1. Pemko
 - 2. Markar Products, Inc.
 - 3. McKinney Products Company; Div. of Assa Abloy

2.6 Mechanical Locks and Latches:

A. Campus Preferred Manufacturers:

1. Best Access Systems – 45H Series
2. Corbin Russwin – ML2000 Series
3. Schlage Lock Company; an Ingersoll-Rand Company – L94 Series
4. Assa Abloy 8200 Series mortise locks

2.7 Electric Mortise Locksets:

A. Campus Preferred Manufacturer:

1. Best Access Systems – 45H Series.

2.8 Surface Bolt:

A. Campus Preferred Manufacturer:

1. Door Controls International
2. Don-Jo Manufacturing
3. Hager Companies
4. Ives: H.B. Ives
5. Rockwood Manufacturing Company
6. Triangle Brass Manufacturing Company, Inc.

2.9 Flush Bolts:

A. Campus Preferred Manufacturers:

1. Door Controls International
2. Don-Jo Manufacturing
3. Hager Companies
4. Ives: H.B. Ives
5. Rockwood Manufacturing Company
6. Triangle Brass Manufacturing Company, Inc.

2.10 Exit Devices:

A. Prefer rim device over vertical rods.

B. Preferred Manufacturer:

1. Von Duprin, Division of Allegion – Series 98 or 99.
2. Corbin Russwin – Series ED5000.

3. Not Allowed: Adams Rite Manufacturing Co. – Products are low quality and don't hold up.

2.11 Cylinders:

- A. Small format interchangeable core type, constructed from brass or bronze, stainless steel, or nickel silver.
- B. Number of Pins: Seven
- C. Mortise Type: Threaded cylinders with rings and appropriate cam to suit lock function and type.
- D. Function: D-Storage; R-Classroom; N-Passage, A-Office, TA-Dormitory.
- E. Required Manufacturer:
 1. Best Access Systems.
 2. Medeco Keymark

2.12 Door Cylinders:

- A. Best Model 1E Series or equivalent (Arrow, general).

2.13 Construction Keying:

- A. Construction Master Keys:
 1. Provide temporary construction master keys (20 construction master keys and 2 control keys).
 2. See Key Schedule below.

2.14 Construction Cylinders:

- A. Provide construction cores.
- B. Permanent Keying: University installs permanent cores.

2.15 Electric Strikes:

- A. Campus Preferred Manufacturers:
 1. Hes Innovations (1006, 9600)
 2. Von Duprin

2.16 Operating Trim (push/pulls):

- A. Campus Preferred Manufacturers:
 1. Don-Jo Manufacturing
 2. Forms & Surfaces

3. Triangle Brass Manufacturing Company, Inc.

2.17 Accessories for Pairs of Doors:

A. Campus Preferred Manufacturers:

1. Coordinators:
 - Don-Jo Manufacturing
 - Hager Companies
 - Ives: H.B. Ives
 - Door Controls Internationals
2. Removable Mullions:
 - Von Duprin, Division of Allegion
 - Corbin Russwin Architectural Hardware, Division of Assa Abloy.
 - Note: "Key Removable" when needed.
3. Astragals:
 - National Guard Products, Inc.
 - Pemko Manufacturing Company, Inc.
 - Reese Enterprises, Inc.

2.18 Closers:

A. Campus Preferred Manufacturers:

1. Surface-Mounted Closers:
 - LCN, Division of Ingersol-Rand, 4040 Series, mounting: inside of door, parallel arm preferred.
 - Corbin Russwin, DC6200 Series.
2. Electromechanical Closers:
 - LCN, Division of Allegion, 4041 Series
 - Norton, Division of Assa Abloy
3. Concealed Floor Closers: Not preferred because replacement is expensive and difficult.
4. Closer Holder Release Devices:
 - Not preferred because of wear and tear on top hinge.
 - Corbin Russwin Architectural Hardware, Division of Assa Abloy.
 - Rixson-Firemark, Inc., Division of Assa Abloy.
5. Overhead Stops: Not allowed because pull hinges out causing door to sag, and damages door jambs.

2.19 Protective Trim Units:

- A. Campus Preferred Manufacturers:
- B. Metal Protective Trim Units:
 - 1. Don-Jo Manufacturing
 - 2. IPC Door and Wall Protection Systems, Inc.
 - 3. Triangle Brass Manufacturing Company, Inc.

2.20 Stops and Holders:

- A. Preferred Manufacturers:
 - 1. Don-Jo Manufacturing
 - 2. Ives: H.B. Ives
 - 3. Norton Door Controls, Division of Assa Abloy.
 - 4. Rixson-Firemark, Inc., Division of Assa Abloy.
 - 5. Triangle Brass Manufacturing Company, Inc.

2.21 Door Gasketing:

- A. Campus Preferred Manufacturers:
 - 1. National Guard Products, Inc.
 - 2. Pemko Manufacturing Company, Inc.

2.22 Door Bottoms:

- A. Campus Preferred Manufacturers:
 - 1. National Guard Products, Inc.
 - 2. Pemko Manufacturing Company, Inc.

2.23 Thresholds:

- A. Meet ADA Access requirements
- B. Campus Preferred Manufacturers:
 - 1. National Guard Products, Inc.
 - 2. Pemko Manufacturing Company, Inc.
 - 3. Rixson-Firemark, Inc., Division of Assa Abloy.

2.24 Key Schedule

- A. Closeout Submittal: Key Schedule – Provide hard copies and one electronic copy of completed Key Schedule along with keys separated and labeled.
- B. Use this form to list all keys provided on project referencing appropriate Sections. The Campus prefers to have one listing for all keys.















Key Schedule for {Crandall Gym Renovation} {Building 60}						
Purpose / Location	Room Number	Keys Required	Total Keys	Model Number	Manufacturer	Section Reference
Toilet Accessories		2/ each building restroom/ accessory keyed differently				10 28 00 Toilet, and Bath Accessories
Plumbing		2/ each, where applies				22 00 00 – Plumbing
Plumbing Padlocks		2/ each Padlock (SFIC cores)				22 00 00 – Plumbing
HVAC Equipment Panels		2/ each Panel				23 00 00 – HVAC
Electrical Panels		2/ each				26 00 00 – Electrical
Lighting Control Panels		2/ each Panel				26 00 00 – Electrical

Key Schedule for {Crandall Gym Renovation} {Building 60}						
Purpose / Location	Room Number	Keys Required	Total Keys	Model Number	Manufacturer	Section Reference
Lighting Switches		2/ each switch				26 00 00 – Electrical
Electrical Yard, Equipment, & Switches Padlocks		2/ each Padlock (SFIC cores)				26 00 00 – Electrical
Communications Equipment Padlocks		2/ each Padlock (IC cores)				27 00 00 - Communications
Electronic Safety and Security Panels		2/ each				28 00 00 – Electronic Safety and Security

HARDWARE LISTINGS
 Opt. #: OPT0309866-V2













HARDWARE GROUP NO. 01

Provide each PR door(s) with the following:

2	EA	PIVOT SET	7215 SET		626	IVE
2	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-9949-EO-LBL		626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-9949-NL-OP-110MD-LBL-CON		626	VON
1	EA	RIM CYLINDER	12E72 L/C		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
2	EA	LONG DOOR PULL	9264F 36" 20" O		630-316	IVE
2	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT (AS REQUIRED)		689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT (AS REQUIRED)		689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT (AS REQUIRED)		689	LCN
1	EA	RAIN DRIP	142AA (OMIT @ OVERHANG)		AA	ZER
2	EA	SEAL	WEATHER SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O
2	EA	DOOR SWEEP	8192AA		AA	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
4	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
2	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON

HARDWARE GROUP NO. 02

Provide each SGL door(s) with the following:














3	EA	HINGE	5BB1HW SH 4.5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELECTRIFIED MORTISE LOCK	45HW-7-DEU-15-J-RQE-DS		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	LOCK GUARD	LG12		630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA (OMIT @ OVERHANG)		AA	ZER
1	SET	SET SEAL	429AA-S (@ HEAD & JAMBS)		AA	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-4R 900-BBK 120/240 VAC OR BY DIV. 28			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO- POINT WIRING DIAGRAM			VON

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HARDWARE GROUP NO. 03

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW SH 4.5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-NL-OP-110MD-CON		626	VON
1	EA	RIM CYLINDER	12E72 L/C		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	DOOR PULL	VR910 NL SNB		630	IVE
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS18L/FS18S (AS REQUIRED)		BLK	IVE
1	EA	RAIN DRIP	142AA (OMIT @ OVERHANG)		AA	ZER
1	SET	SET SEAL	429AA-S (@ HEAD & JAMBS)		AA	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO- POINT WIRING DIAGRAM			VON

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HARDWARE GROUP NO. 04

Provide each PR door(s) with the following:

2	EA	PIVOT SET	7215 SET		626	IVE
2	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-9949-EO-LBL		626	VON
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-9949-NL-OP-110MD-LBL-CON		626	VON
1	EA	RIM CYLINDER	12E72 L/C		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
2	EA	LONG DOOR PULL	9264F 36" 20" O		630-316	IVE
2	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT (AS REQUIRED)		689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT (AS REQUIRED)		689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT (AS REQUIRED)		689	LCN
2	EA	FLOOR STOP	FS18L/FS18S (AS REQUIRED)		BLK	IVE
1	EA	RAIN DRIP	142AA (OMIT @ OVERHANG)		AA	ZER
2	EA	SEAL	WEATHER SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O
2	EA	DOOR SWEEP	8192AA		AA	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
4	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
2	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON

HARDWARE GROUP NO. 05

Provide each SGL door(s) with the following:








3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	PRIVACY LOCK	45H-7-LT-15-J-VIB		626	BES
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	MOP PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV AS REQ'D		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

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HARDWARE GROUP NO. 06

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	CLASSROOM DEADLOCK	45H-7-RD		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	MOP PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV AS REQ'D		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER







HARDWARE GROUP NO. 07

Provide each RU door(s) with the following:

1	SET	NOTE	ALL HARDWARE BY ROLL UP DOOR MANUFACTURER/SUPPLIER			B/O
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HARDWARE GROUP NO. 08

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	OFFICE LOCK	45H-7-A-15-J-VIT		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS439		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER













HARDWARE GROUP NO. 09

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELECTRIFIED MORTISE LOCK	45HW-7-DEU-15-J-RQE-DS		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-4R 900-BBK 120/240 VAC OR BY DIV. 28			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON








HARDWARE GROUP NO. 10

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW SH 4.5 X 4.5 NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELEC PANIC HARDWARE	RX2-QEL-PA-99-NL-OP-110MD 24 VDC		626	VON
1	EA	RIM CYLINDER	12E72 L/C		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	DOOR PULL	VR910 NL SNB		630	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	RAIN DRIP	142AA (OMIT @ OVERHANG)		AA	ZER
1	SET	SET SEAL	429AA-S (@ HEAD & JAMBS)		AA	ZER
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON






HARDWARE GROUP NO. 11

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	OFFICE LOCK	45H-7-A-15-J-VIT		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ SRT		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER





HARDWARE GROUP NO. 12

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	45H-7-D-15-J		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CCV AS REQ'D		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER






HARDWARE GROUP NO. 13

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	OFFICE LOCK	45H-7-A-15-J-VIT		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	FLOOR STOP	FS439		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER






HARDWARE GROUP NO. 14

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	OFFICE LOCK	45H-7-A-15-J-VIT		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ SRT		689	LCN
1	EA	SEAL	DOOR SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O












HARDWARE GROUP NO. 15

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	OFFICE LOCK	45H-7-A-15-J-VIT		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	MOUNTING PLATE	4040XP-18 SRT (AS REQUIRED)		689	LCN
1	EA	FLOOR STOP	FS439		630	IVE
1	EA	SEAL	DOOR SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O

HARDWARE GROUP NO. 16

Provide each SGL door(s) with the following:














3	EA	HINGE	5BB1HW SH 4.5 X 4.5 NRP		630	IVE
1	EA	OFFICE LOCK	45H-7-A-15-J-VIT		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	LOCK GUARD	LG12		630	IVE
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT (AS REQUIRED)		689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT (AS REQUIRED)		689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT (AS REQUIRED)		689	LCN
1	EA	FLOOR STOP	FS18L/FS18S (AS REQUIRED)		BLK	IVE
1	EA	SEAL	WEATHER SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O
1	EA	DOOR SWEEP	8192AA		AA	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE

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HARDWARE GROUP NO. 17

Provide each SGL door(s) with the following:

1	EA	PIVOT SET	7215 SET		626	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	RIM CYLINDER	12E72 L/C		626	BES
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-99-NL-OP-110MD-CON		626	VON
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	LONG DOOR PULL	9264F 36" 20" O		630-316	IVE
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	PA MOUNTING PLATE	4040XP-18PA SRT (AS REQUIRED)		689	LCN
1	EA	CUSH SHOE SUPPORT	4040XP-30 SRT (AS REQUIRED)		689	LCN
1	EA	BLADE STOP SPACER	4040XP-61 SRT (AS REQUIRED)		689	LCN
1	EA	SEAL	WEATHER SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O
1	EA	DOOR SWEEP	8192AA		AA	ZER
1	EA	THRESHOLD	547A-223(OR AS REQ'D. OR PER DETAIL/CONDITIONS)		A	ZER
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON

HARDWARE GROUP NO. 18

Provide each SGL door(s) with the following:









3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	45H-7-D-15-J		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	OH STOP	90S		630	GLY
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER

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HARDWARE GROUP NO. 19

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELECTRIFIED MORTISE LOCK	45HW-7-DEU-15-J-RQE-DS		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	OH STOP	100S ADJ		630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ SRT		689	LCN
1	EA	SEAL	DOOR SEALS BY DOOR/FRAME MANUFACTURER/SUPPLIER			B/O
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-4R 900-BBK 120/240 VAC OR BY DIV. 28			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON

HARDWARE GROUP NO. 20

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	POWER TRANSFER	EPT10 CON		689	VON
1	EA	ELECTRIFIED MORTISE LOCK	45HW-7-DEU-15-J-RQE-DS		626	BES
1	EA	PERMANENT CORE	COREMAX		626	BES
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS439		630	IVE
1	EA	GASKETING	188SBK PSA		BK	ZER
2	EA	WIRE HARNESS	CON X LENGTH AS REQ'D			VON
1	EA	CARD READER	CARD READER AND WIRING BY DIV. 28			B/O
1	EA	DOOR CONTACT	7764 OR BY DIV. 28		628	SCE
1	EA	POWER SUPPLY	PS902 900-4R 900-BBK 120/240 VAC OR BY DIV. 28			VON
1	EA	WIRING DIAGRAM	PROVIDE FACTORY POINT-TO-POINT WIRING DIAGRAM			VON

END OF SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This 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. Aluminum Windows.
 - 2. Fire Rated Steel Windows
 - 3. Doors.
- B. Related Sections include the following:
 - 1. Division 8 Section "Steel Doors and Frames".
 - 2. Division 8 Section "Flush Wood Doors".

1.3 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- C. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for 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.\

- E. Fire Rated Glass: Glass that is manufactured and tested by a testing lab/ agency recognized by DSA.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300.

1.5 SUBMITTALS

- A. Concurrent Review Requirements: Submit submittals of this section with other sections requiring glazing specified in this section.
 - 1. Division 8 Section "Steel Doors and Frames."
 - 2. Division 8 Section "Flush Wood Doors".
 - 3. Division 8 Section "Aluminum-Framed Storefronts."
- B. Product Data: For each glass product and glazing material indicated.
- C. Samples: For each glazing products, in the form of 12-inch- square Samples for glass and of 12-inch- long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
 - 1. Insulating glass for each designation indicated.
 - 2. Fire-rated glazing.
- D. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
 - 1. List by windows and door types scheduled on Drawings.

- E. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
 - 1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.
- F. Qualification Data: For installers. Minimum of 10 years of documented experience for supervisory staff in the installation of glass and glazing.
- G. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.
- H. Product Test Reports: For each types of glazing products specified.

1.6 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- 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.
- C. Source Limitations for Glass: Obtain glazing products through one source from a single manufacturer for each glass type.

- D. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- E. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.
 - 1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- F. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
 - 1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
- G. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
- H. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- I. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.
 - 1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency or manufacturer acceptable to authorities having jurisdiction.
 - 2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
- J. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are

indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

K. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:

1. Insulating Glass Certification Council.
2. Associated Laboratories, Inc.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass 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.

B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which 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.
- C. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Non-Fire-Rated Glass Manufacturers: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
1. Vitro Architectural Glass (Basis of Design).
 2. Guardian.
 3. Pilkington.
 4. Visteon.
 5. Or equal (Reference substitution requirements in Division 01 Section)
- B. Non-Fire-Rated Glazing Fabricators: Subject to compliance with requirements, provide either the named fabricator or an equal fabricator by one of the other fabricators specified.
1. Oldcastle Glass. (Basis of Design)
 2. Viracon.
 3. Guardian.
 4. Or equal (Reference substitution requirements Division 01 Section)
- C. Fire-Rated Glazing Fabricators: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
1. FireLite NT by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products (Basis of Design)
 - a. Premium grade, lamination on one side, 3/16 inch thick.
 2. Interedge Technologies.
 3. Oldcastle Glass.
 4. Pilkington.
 5. Pyran Star F by Schott.
 6. Safti.
 7. Or equal (Reference substitution requirements in Division 01 Section)

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Treated Float Glass (Safety Glass): ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
 - 1. For uncoated glass, comply with requirements for Condition A.
 - 2. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 - 3. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.
- C. Tinted Insulating-Glass Units: Insulated glass units for all exterior storefronts, doors and aluminum windows: Double pane, low-e with glass to elastomer edge seal. Outer pane of tinted glass, inner pane of clear glass. Place reflective coating on No.2 surface within the unit.
 - 1. Product: Solarban 60 Gray by Vitro Architectural Glass
 - 2. Visible Light Reflectance: 7%.
 - 3. U-Value:
 - a. Winter Night time: 0.29.
 - b. Summer Day time: 0.28
 - 4. Shading Coefficient: 0.33.
 - 5. Solar Heat Gain Coefficient: 0.29.
 - 6. Light to Solar Gain (LSG): 1.25.

2.3 FIRE-RATED GLAZING PRODUCTS

- A. Monolithic Ceramic Glazing Material: Proprietary product in the form of clear flat sheets of 3/16-inch nominal thickness weighing 2.5 lb/sq. ft., and as follows:
 - 1. Fire-Protection Rating: As indicated for the fire window in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 2. Wire glass is not acceptable.

2.4 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

2.5 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
 - 1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will 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.
 - 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.
- B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- C. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep system.
 - 3. Minimum required face or edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 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. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- E. 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.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. 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.

- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until just before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant where indicated.
- G. Center glass lites in openings on setting blocks and press firmly against tape 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.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Fabricate compression gaskets in 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. 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. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- C. 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; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08 80 00

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following interior gypsum board:
 - 1. Type X (GWB).
 - 2. Abuse and Water Resistant (GWB-WR).
 - 3. Impact Resistant Gypsum Board (GWB-IR)
- B. Related Sections include the following:
 - 1. Division 5 Section "Cold-Formed Metal Framing" for metal stud framing and furring that supports gypsum board.
 - 2. Division 7 Section "Fire-Resistive Joint Systems" for head-of-wall assemblies that incorporate gypsum board.
 - 3. Division 9 Section "Painting" for primers and finishes applied to gypsum board surfaces.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For the following products:
 - 1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.
 - 2. Finishes: Provide Level 4 and 5 of gypsum board finish indicated for use in exposed locations. 4 by 4 foot sample of each.
 - a. Finishes: For each finish indicated and on same backing indicated for Work.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR

3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency acceptable to DSA.
- C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- D. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - b. Each finish indicated.
 - c. Each areas such as walls, ceilings, and soffits.
 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 3. Simulate finished lighting conditions for review of mockups.
 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are 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.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of gypsum board that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Interior Gypsum Board: Subject to compliance with requirements, provide products by one of the following:
 - 1. USG Corporation.
 - 2. National Gypsum Company.
 - 3. G-P Gypsum.
 - 4. Or equal (Reference substitution requirements in Division 01 Section)
- B. Sound Control Wall Board: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pabco Corporation.
 - 2. Certainteed
 - 3. Gold Bond
 - 4. Or equal (Reference substitution requirements in Division 01 Section)

- C. Steel Trim Accessories: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amico.
 - 2. Or equal (Reference substitution requirements in Division 01 Section)
 - 3. Steel Trim Accessories:

2.2 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36 or ASTM C 1396, as applicable to type of gypsum board indicated and whichever is more stringent.
- B. Type X:
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- C. Water-Resistant Gypsum Backing Board: ASTM C 630 or ASTM C 1396.
 - 1. Core: 5/8 inch, Type X.
 - 2. Use: Toilet rooms and janitor's closets walls with painted finish.
 - 3. Products:
 - a. SHEETROCK Brand Water-Resistant Firecode Core Gypsum Panels by USG.
 - b. Gold Bond Brand Moisture-Resistant Fire-Resistant Gypsum Board by National Gypsum.
 - 4. Or equal (Reference substitution requirements in Division 01 Section)
- D. Sound Control Gypsum Board
 - 1. Manufactured to ASTM C1278 material standards.
 - 2. Core: 5/8 inch, Type X.
 - 3. Products:
 - a. Sound Break XP by Goldbond (Basis of Design)
 - b. Quietrock by Pabco.
 - c. Silent FX by Certainteed
 - 4. Type and Thickness: Type X, 5/8 inch thick.
- E. Impact Resistant Type: ASTM C1278 and ASTM C1629.
 - 1. Core: 5/8 inch, Type X.
 - 2. High-density paperless gypsum and cellulose wall panels with long edges.

3. Products:
 - a. FIBEROCK Brand VHI panels by USG.
 - b. Hi-Impact XP Wallboard by National Gypsum.
4. Or equal (Reference substitution requirements in Division 01 Section)

F. Fiber-Reinforced Gypsum Board:

1. Manufactured to ASTM C1278 material standards.
2. Product: Fiberock Brand Aqua-Tough Panel by USG Corp. (Basis of Design)
3. Type and Thickness: Type X, 5/8 inch thick.
4. Description: Abuse resistant, water resistant, mold resistant, fire resistant, environmentally friendly (made from 95% recycled materials), smooth paintable surface.
5. Stud Spacing: Up to 24 inches on center on ceilings with Type X, 5/8 inch thick.
6. Use:
 - a. On ceilings over sheet waterproofing and with epoxy painted finish.
 - b. Toilet rooms and janitor's closets ceilings with epoxy painted finish.

2.4 TRIM ACCESSORIES

A. Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - 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. Casing bead; J-shaped; exposed long flange receives joint compound
 - g. Expansion (control) joint.
 - h. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
- C. Acoustical Sealant: Sheetrock Acoustical Sealant by USG or equal.
- D. Thermal and Acoustical Insulation: As specified in Division 7 Section "Building Insulation."
- E. Gypsum Board Adhesives: High performance latex-based construction adhesive designed for gypsum board applications.
 - 1. Green Series SW-325 Shear & Drywall Adhesive by OSI.
 - 2. Drywall Adhesive GDWA by Grabberman.
 - 3. Or equal (Reference substitution requirements in Division 01 Section)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- 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.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Notify Inspector of Record 48 hours in advance of when coats of mud are being applied to confirm correct coats.
- C. 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.

- D. 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.
- E. 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.
- F. Form control and expansion joints with space between edges of adjoining gypsum panels.
- G. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 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.
- H. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. 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.
- 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.

3.3 INSTALLING 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 C 840 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. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated.
 - 4. U-Bead: Use at exposed panel edges.
 - 5. Casing Bead: Provide at edges of Gyp. Bd. where material changes occurs or when gyp. bd. butt to windows and/or doors to provide a straight and level finished edge.
 - 6. Expansion (control) joint.
 - 7. Curved-Edge Cornerbead: Use at curved openings.

3.4 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 and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Comply with GA 214 for Level definitions.
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for fiber reinforce plastic panels.
 - 3. Level 3: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces that will be exposed to view with flat and non-flat paint finish.
 - a. Primer and its application to surfaces are specified in other Division 9 Sections.

3.5 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. 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 09 29 00

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SECTION 09 30 13 – TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 1. Porcelain Floor Tile and Base
 2. Porcelain Wall Tile
 3. Tile trims
 4. Grout
 5. Solid polymer thresholds installed as part of tile installations.
 6. Waterproof membrane for tile installations.
 7. Cementitious backer units installed as part of tile installations.
- B. Related Sections include the following:
 1. Division 3 Section "Cast-in-Place Concrete" for monolithic slab finishes specified for tile substrates.
 2. Division 9 Section "Gypsum Board" for moisture resistant gypsum board.
 3. Division 9 Section "Finish Schedule" for color selection.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

1.4 SYSTEM DESCRIPTION

- A. Ground and Floor Surfaces:
 1. Minimum 0.6 static coefficient of friction under wet conditions per ADAAG A4.5.1. and ASTM D2047.

1.5 PERFORMANCE REQUIREMENTS

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
 - 1. Level Surfaces: Minimum 0.6.
 - 2. Step Treads: Minimum 0.6.
 - 3. Ramp Surfaces: Minimum 0.8.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- 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.
 - 1. Propose locations of expansion, contraction, control, and isolation joints if not indicated on Drawings.
- C. Installation Method: Show TCA installation method number for each tiled area in tabulated form.
- D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.
- E. Product Certificates: For each type of product, signed by product manufacturer.
- F. Qualification Data: For Installer.
- G. Material Test Reports: For each tile-setting and -grouting product.

1.7 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
 - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- D. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

1.9 PROJECT 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.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of ceramic tile and accessories that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year.

- B. Installer's Warranty: 1 year.

1.11 EXTRA MATERIALS

- 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. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Porcelain Tile: Subject to compliance with requirements, provide products by one of the following manufacturers.
 - 1. Crossville, Inc. (Basis of Design)
 - 2. Daltile; Div. Dal-Tile International Corp.
 - 3. American Olean
 - 4. Or approved equal, (See 01 60 00 for substitution requirement)
- B. Solid-Polymer Thresholds: Subject to compliance with requirements, provide products by one of the following manufacturers.
 - 1. Avonite, Inc.
 - 2. DuPont Polymers.
 - 3. Formica Corporation.
 - 4. Nevamar; International Paper; Decorative Products Division.
 - 5. Or equal (Reference substitution requirements in Section 01 25 13).
- C. Setting, Grouting, and Waterproofing Materials: Subject to compliance with requirements, provide products by one of the following manufacturers.
 - 1. Custom Building Products.
 - 2. Laticrete International Inc.
 - 3. Mapei Corporation.
 - 4. Or equal (Reference substitution requirements in Section 01 25 13).
- D. Cementitious Backer Board: Subject to compliance with requirements, provide products by one of the following manufacturers.
 - 1. USG Corporation; DUROCK Cement Board.
 - 2. National Gypsum Company; PermaBase.
 - 3. C-Cure; C-Cure Board 990.

4. Custom Building Products; Wonderboard.
5. Or equal (Reference substitution requirements in Section 01 25 13).

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
 1. Floor Tile (Porcelain) (FT-1)
 - a. Tile Size - 12" x 12" by Crossville (Basis of Design)
 - 1) Tile #: BLOX 2.0
 - a) Color: CBX08 Sea Otter
 2. Cove Base Tile (Porcelain) (CB-1)
 - a. Tile Size - 6" X 8" by Crossville (Basis of Design)
 - 1) Tile #: BLOX 2.0
 - a) Color: CBX08 Sea Otter
 3. Wall Tile (Porcelain) (WT-1)
 - a. Tile Size - 12" x 24" by Crossville (Basis of Design)
 - 1) Tile #: BLOX 2.0
 - a) Color: CBX03 Slinky
 4. Wall Tile (Porcelain) (WT-2) Accent Tile
 - a. Tile Size- 12" x 12" by Crossville (Basis of Design)
 - 1) Tile #: BLOX 2.0
 - a) Color: CBX08 Sea Otter
 5. Wall Tile (Porcelain) (WT-3) Trim Tiles
 - a. Tile- 4" x 12" by Crossville (Basis of Design)
 - 1) Tile #: Blox 2.0
 - a) Color: CBX03 Slinky
 6. Wall Tile (Porcelain) (WT-4) Trim Tiles Bullnose Accent
 - a. Tile- 4" x 12" Single Bullnose, by Crossville (Basis of Design)
 - 1) Tile #: BLOX 2.0
 - a) Color: CBX08 Sea Otter

- D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

- A. As scheduled on the "Finish Schedule" noted in the plans.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
- B. Solid Polymer Thresholds: Made from homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without precoated finish.

2.5 SHEET WATERPROOFING FOR TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10.
- B. Thin (1/32 inch) bonded, load bearing sheet membrane for waterproofing. Alloy made from Chlorinated Polyethylene (CPE) with nonwoven fabric laminated to both sides.
 1. System Performance: 1-14 "Extra Heavy Service" cycles per ASTM C627.
 2. Hardness: 82 shore A per ASTM D2240.
 3. Tensile Strength: 1600 psi per ASTM D412 Die C.
 4. Elongation: 44% per ASTM D412 Die C.
 5. Tear Strength: 400 psi per ASTM D624 Die C.
 6. Shear Strength: Pass per ANSI A118.10-1993.
 7. Shear Strength - Water Immersion: Pass per ANSI A118.10-1993.
 8. Fungus & microorganism Resistance: Pass per ANSI A118.10-1993.
 9. Seam Strength: Pass per ANSI A118.10-1993.
 10. Waterproofness: Pass per ANSI A118.10-1993.

2.6 FLUID-APPLIED WATERPROOFING AND CRACK SUPPRESSION FOR TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10.

- B. Fabric-Reinforced, Fluid-Applied Product: System consisting of liquid-latex rubber, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), and fabric reinforcement.

2.7 SETTING AND GROUTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.1A and as specified below:
 - 1. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
 - 2. Latex Additive: Manufacturer's standard water emulsion.
 - 3. Products:
 - a. MAPEI, Mapecem 102, Powder, MAPEI, Planicrete AC (Liquid).
 - b. 3701 (liquid) Additive with 226 (powder) by Laticrete.
 - c. Custom Building Products: Acrylic Mortar Admix
 - d. Or equal.
- B. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, consisting of the following:
 - 1. Prepackaged dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive.
 - a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.
 - 2. Products:
 - a. MAPEI: Ultraflex 2, Walls: MAPEI Ultralite.
 - b. 254 Platinum by Laticrete.
 - c. Custom Building Products: MegaFlex.
 - d. Or equal.
- C. Chemical-Resistant, Water-Cleanable, Grouting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, and certified by manufacturer for intended use.
 - 2. Products:
 - a. Custom Building Products: 100% Solids Epoxy Grout. (Basis of Design)
 - b. MAPEI: Kerapoxy IEG.
 - c. SpectraLock Pro by Laticrete.
 - d. Or equal.

2.8 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 7 Section "Joint Sealants."
 - 1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

2.9 CEMENTITIOUS BACKER UNITS

- A. Properties:
 - 1. Aggregated portland cement board with coated glass-mesh reinforcement scrim.
 - 2. Comply with ANSI A118.9.
 - 3. Pass ASTM E136 for non-combustibility.
 - 4. Thickness: As indicated on Drawings.
 - 5. Lengths: Maximum lengths available to minimize end-to-end butt joints.

2.10 MOISTURE AND MOLD-RESISTANT GYPSUM BOARD

- A. Comply with requirements of Division 9 Section "Gypsum Board".
- B. Substrates for painted surfaces in toilet rooms. Do not use as substrate for tile application.

2.11 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: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications, stainless steel; ASTM A 666, 300 Series exposed-edge material.
- 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 that does not change color or appearance of grout.

2.12 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 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 installed tile.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
 - a. Sub-floor and Vertical Surfaces: 1/4 inch in 10 feet.
 - 2. 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 before installing tile.
 - 3. 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.

3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

- B. Provide concrete substrates for tile floors installed with mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
 - 1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.
 - 2. Remove protrusions, bumps, and ridges by sanding or grinding.
- C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, 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.

3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. 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.
- D. 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.
- E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- F. Lay out tile wainscots to next full tile beyond dimensions indicated.
- G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Locate joints in tile surfaces directly above joints in concrete substrates.

H. Grout tile to comply with requirements of the following tile installation standards:

1. For chemical-resistant epoxy grouts, comply with ANSI A108.6.

3.4 CEMENTITIOUS BACKER UNIT INSTALLATION

A. Install cementitious backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

C. At showers, tubs, and where indicated, install cementitious backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.5 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.

B. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.6 FLOOR TILE INSTALLATION

A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.

B. Joint Widths: 1/16 inch unless specified otherwise.

C. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

D. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout

joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.7 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Install tile on walls with the following joint widths:
 - 1. Glazed Wall Tile: 1/16 inch.

3.8 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove epoxy 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.
 - 3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.9 FLOOR TILE INSTALLATION, TCA ASSEMBLY

- A. Tile Installation: Interior floor installation on concrete; cement mortar bed (thickset) bonded to concrete; TCA F112 and ANSI A108.1A.

1. Grout: Chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.

3.10 WALL TILE INSTALLATION, TCA ASSEMBLY

- A. Tile Installation: Interior wall installation over waterproof membrane, cementitious backer units; thin-set mortar; TCA W244F-07 and ANSI A108.5.
 1. Grout: Chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.

END OF SECTION 09 30 13

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SECTION 09 51 10 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Acoustical ceiling panels
 - 2. Metal Suspension systems for ceilings.
- B. Related Sections include the following:
 - 1. Division 7 Section "Joint Sealants" for acoustical sealant requirements.

1.3 DEFINITIONS

- A. AC: Articulation Class.
- B. CAC: Ceiling Attenuation Class.
- C. LR: Light Reflectance coefficient.
- D. NRC: Noise Reduction Coefficient.

1.4 SYSTEM DESCRIPTION

- A. Information below from the current DSA Interpretation of Regulations (IR) Document Metal Suspension Systems for Lay In Panel Ceilings (IR25-2.13) references 2013 CBC, Section 1616 A.1.20 and has not been updated to current 2019 CBC referencing.
 - 1. Applies to ceiling systems whose total weight, including air conditioning grilles and light fixtures, does not exceed four (4) psf. Heavier systems and those supporting lateral loads from partitions will require special design details.

2. SUSPENSION SYSTEM COMPONENTS: Shall comply with ASTM C635 and Section 5.1 of ASTM E580.
 - a. The ceiling grid system must be rated heavy duty as defined by ASTM C635. 2.2
 - b. Suspension wires shall be #12 gage (0.106" diameter), soft annealed, and galvanized steel wires with Class 1 coating.
 - c. Main runners, cross runners, splices, expansion devices, and intersection connectors shall be designed to carry a mean ultimate test load of not less than 180 lbs. in compression and tension per ASTM E580 Section 5.1.2.
3. SUSPENSION SYSTEM INSTALLATION: Shall comply with ASTM C636 and Section 5.2 of ASTM E580.
 - a. #12 gage hanger wires may be used for up to and including a 4 foot by 4 foot grid spacing and shall be attached to main runners. 3.2
 - b. Provide #12 gage hanger wires at the ends of all main and cross runners within eight (8) inches of the support or within one-fourth (1/4) of the length of the end tee, whichever is least, for the perimeter of the ceiling area.
 - c. Perimeter wires are not required when the length of the end tee is eight (8) inches or less, breaks, soffits or discontinuous areas. Hanger wires that are more than 1 in 6 out of plumb are to have counter sloping wires.
 - d. Ceiling grid members shall be attached to two (2) adjacent walls per ASTM E580, Section 5.2.3. Ceiling grid members shall be at least 3/4 inch clear of other walls. If walls run diagonally to ceiling grid system runners, one end of main and cross runners should be free, and a minimum of 3/4 inch clear of wall.
 - e. The width of the perimeter supporting closure angle shall be not less than 2 inches.

Grid systems with specialty angles and support clips may be acceptable in accordance with Section 11 below.

At the perimeter of the ceiling area where main or cross runners are not connected to the adjacent wall, provide interconnection between the runners at the free end to prevent lateral spreading. A metal strut or a 16 ga. wire with a positive mechanical connection to the runner may be used. Where the perpendicular distance from the wall to the first parallel runner is 12 inch or less, this interlock is not required.
4. LATERAL FORCE BRACING: Lateral force bracing is required per this section for all ceiling areas. The spacing of the bracing assemblies must be shown on the construction documents.
 - a. Exception: Lateral force bracing may be omitted for suspended acoustical ceiling systems with a ceiling area of 144 square feet or less, and fire rated suspended acoustical ceiling systems with a ceiling area of 96 square feet or less, when perimeter support, in accordance with Section 3.4 of this IR or with ASTM E580

- Sections 5.2.2 and 5.2.3, are provided and perimeter walls are designed to carry the ceiling lateral forces.
- b. Provide lateral force bracing assemblies consisting of a compression strut and four (4) #12 gage splayed bracing wires oriented 90 degrees from each other
 - c. Lateral force bracing assemblies shall be spaced at a maximum of 12 feet by 12 feet on centers for school buildings and 8 feet by 12 feet on centers for essential services buildings. There shall be a brace assembly a distance of not more than one half of the above spacing from each surrounding wall, expansion joint and at the edges of any ceiling vertical offsets.
 - d. The slope of bracing wires shall not exceed 45 degrees from the plane of the ceiling and wires shall be taut. Splices in wires are not permitted without DSA approval.
 - e. Compression struts shall be adequate to resist the vertical component induced by the bracing wires and shall not be more than one (horizontal) in six (vertical) out of plumb.
5. ATTACHMENT OF HANGER AND BRACING WIRES:
- a. Fasten hanger wires with not less than three (3) tight turns in three (3) inches. Hanger wire loops shall be tightly wrapped and sharply bent to prevent any vertical movement or rotation of the member within the loops (see ASTM E580, Section 5.2.7.2).
Fasten #10 or #12 bracing wires with four (4) tight turns. Make all tight turns within a distance of 1-1/2 inches.
 - b. Hanger or bracing wire anchored to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.
 - c. Separate all ceiling hanger and bracing wires at least six (6) inches from all unbraced ducts, pipes, conduit, etc.
 - d. Hanger wires shall not attach to or bend around interfering material or equipment. Provide trapeze or other supplementary support members at obstructions to typical hanger spacing. Provide additional hangers, struts or braces as required at all ceiling breaks, soffits, or discontinuous areas.
 - e. Hanger wires that are more than one (horizontal) in six (vertical) out of plumb shall have counter-sloping wires. Perimeter hanger wires at main runners that are positively attached to the perimeter closure angle, counter-sloping is optional. Note: See ASTM C636, Figure 1, for counter-sloping methods.
 - f. When connection details differ from those in the attached figures, attachment of bracing wires to the structure above and to the main runners shall be adequate for the load imposed. The weight (Wp) shall be taken as not less than four (4) psf for calculating seismic forces (Fp).
 - g. When drilled-in concrete anchors or power actuated fasteners are used in reinforced concrete for hanger wires, 1 out of 10 wire/anchor assemblies

must be field tested for 200 lbs. in tension. When drilled-in concrete anchors are used for bracing wires, 1 out of 2 wire/anchor assemblies must be field tested for 440 lbs. in tension in the direction of the wire. Power actuated fasteners in concrete are not permitted for bracing wires.

Note: Drilled-in or shot-in anchors require DSA approval prior to use in pre-stressed concrete.

6. CEILING FIXTURES, TERMINALS, AND DEVICES: All fixtures, terminals, and other devices shall be mounted in a manner that will not compromise ceiling performance in accordance with Section 13.5.6.2.2(5) of ASCE 7-10 as amended by [2013] CBC Section 1616A.1.20 (1616.10.16*) and ASTM E580 Sections 5.3 and 5.4.
 - a. Ceiling panels shall not support any light fixtures, air terminals or devices.
 - b. All light fixtures shall be positively attached to the ceiling suspension systems by mechanical means to resist a horizontal force equal to the weight of the fixture. Screws or approved fasteners are required. A minimum of two attachments are required at each light fixture, per ASTM E580, Section 5.3.1. Recessed or drop-in light fixtures, grilles, mechanical terminals, and flexible sprinkler hose fittings or other services be supported directly on runners classified as ASTM heavy duty, but they must also have a minimum of two (2) #12 gage slack safety wires attached to the fixture at diagonal corners and anchored to the structure above.
 - c. All flush or recessed light fixtures, mechanical terminals, and flexible sprinkler hose fittings or other services weighing 56 lbs. or more must be independently supported by not less than four (4) taut #12 gage wires attached to the housing and to the structure above. The four (4) taut #12 gage wires, including their attachment to the structure above, must be capable of supporting four (4) times the weight of the unit.
 - d. All four foot x four foot light fixtures must have slack safety wires at each corner unless supported per paragraph above.
 - e. Surface-mounted fixtures shall be attached to the main runner with at least two positive clamping devices made of material with a minimum #14 gage. Rotational spring catches do not comply. A #12 gage suspension wire shall be attached to each clamping device to the structure above. Provide additional supports when light fixtures are eight (8) feet or longer. Maximum spacing between supports shall not exceed eight (8) feet.
 - f. Support pendant-mounted light fixtures directly from the structure above with hanger wires or cables passing through each pendant hanger and capable of supporting two (2) times the weight of the fixture. See IR 16-9 for additional requirements for pendant mounted fixtures.
If the pendant mounted light fixture is directly and independently braced below the ceiling, i.e., aircraft cables to walls, then a brace assembly is not required above the ceiling.

If the pendant mounted light fixture is not directly and independently braced below the ceiling, then a bracing assembly, per Figure 1, is required where the pendant hanger penetrates the ceiling. Special details are required to attach the pendant hanger to the bracing assembly to transmit the horizontal force. Exception: Where the weight of the fixture is less than 20 pounds, the compression post shown in Figure 1 is not required.

All lightweight miscellaneous devices, such as strobe lights, speakers, etc., shall be attached to the ceiling grid per Section 7.1 of this IR. In addition, devices weighing more than 10 lbs shall have a #12 slack safety wire anchored to the structure above. Devices weighing more than 20 lbs shall be supported from the structure above per Section 7.3 of this IR.

7. Services within the Ceiling:
 - a. All flexible sprinkler hose fittings, ceiling-mounted air terminals or other services shall be positively attached to the ceiling suspension systems by mechanical means to resist a horizontal force equal to the weight of the component. Screws or approved fasteners are required. A minimum of two attachments are required at each component.
 - b. Flexible sprinkler hose fittings, ceiling-mounted air terminals or other services weighing less than or equal to 20 lb. shall have one (1) #12 gage slack safety wire attached to the terminal or service to the structure above.
 - c. Flexible sprinkler hose fittings, ceiling-mounted air terminals or other services weighing more than 20 lb. but less than or equal to 56 lb. shall have two (2) #12 gage slack safety wires attached to the terminal or service to the structure above.
 - d. Flexible sprinkler hose fittings, ceiling-mounted air terminals or other services weighing more than 56 lb. shall be supported directly from the structure above by not less than four (4) taut #12 gage wires attached to the terminal or service and to the structure above. The four (4) taut #12 gage wires, including their attachment to the structure above, must be capable of supporting four (4) times the weight of the unit.
 - e. Other Devices within the Ceiling:
 - f. All lightweight miscellaneous devices, such as strobe lights, occupancy sensors, speakers, exit signs, etc., shall be attached to the ceiling grid per Section 7.3.1 of the IR. In addition, devices weighing more than 10 lbs. shall have a #12 gage slack safety wire anchored to the structure above per Section 7.2.2 of the IR. Devices weighing more than 20 lbs. shall be supported from the structure above per Section 7.3.4 of this IR.
8. ADDITIONAL REQUIREMENTS:
 - a. Fire Rated Ceilings: Provide a detail and design number for rated ceiling assemblies from an authorized testing agency. The components and installation details must conform in every respect with the listed detail and number. Details shall clearly depict all components, including insulation

materials, framing and attachment of the design so that the assembly can be constructed and inspected accordingly. Pop rivets, screws, or other attachments are not acceptable unless specifically detailed on the drawings and approved by U.L. and State Fire Marshal (SFM) recognized laboratories.

- b. Metal and Other Panels: Metal panels and panels weighing more than one-half (1/2) psf, other than mineral fiber acoustical tile, are to be positively attached to the ceiling suspension runners.
- c. Essential Services Buildings: Exit ways shall be installed in accordance with Section 13.5.6.2.2(1) of ASCE 7-10 as amended by 2013 CBC Section 1616A.1.20 (1616.10.16*). A main or cross runner shall be installed on all sides of each piece of tile, board or panel and each light fixture or grill (see Figure 7, Detail B). Splices or intersection of such runners shall be attached with through connectors such as pop rivets, screws, pins, plates with end tabs or other approved connectors.
- d. Suspended Acoustical Ceilings Below Gypsum Board Ceilings: Where gypsum board or other ceiling finishes are attached to the framing, specific details will be required for the vertical hanger wire and lateral bracing wire support connections to the framing.

B. Structural Performance:

1. CBC Seismic Categories D, E, F.
2. Heavy Duty Grid.
3. Minimum 3/4 inch clearance from grid end to wall.
4. Minimum 2 inch perimeter molding.
5. Grid must be attached on 2 adjacent walls, no attachment on other 2 walls.
6. Perimeter T ends tied together at perimeters on tees that are not attached to perimeter molding.
7. Partition attachment bracing is required to be independent from ceiling splay bracing.
8. Seismic separation joint required for areas greater than 2,500 sq. ft. (or full height partitions).
9. Rigid bracing required for ceiling elevation changes.
10. Interior suspended ceilings, soffits, and bulkheads: Maintain deflection of not more than L/360 of distance between supports.

1.5 SUBMITTALS

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

- B. Samples for Initial Selection: For components with factory-applied color finishes.

- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- long Samples of each type, finish, and color.

- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

- E. Research/Evaluation Reports: For each acoustical panel ceiling and components and anchor and fastener type.

- F. Maintenance Data: For finishes to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

- C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
 - 1. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
 - a. Smoke-Developed Index: 450 or less.
 - b. Flame-Spread Classification: CBC 802.2 and Table 8-A.
 - 1) Flame-Spread Rating: Class 1 (0-25).
- E. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 - 1. CBC 1613.1 and ASCE 7-18.
- F. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages 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.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, 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.

1.9 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical panel ceilings that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 1 year.
- B. Installer's Warranty: 1 year.

1.11 EXTRA MATERIALS

- 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. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed.
 - 2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2.0 percent of quantity installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acoustical Panels: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Armstrong World Industries, Inc. (Basis of Design)
 - 2. Or equal. Refer to Division 1 for substitution requirements
- B. Suspension Systems: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.

1. Armstrong World Industries, Inc. (Basis of Design)
2. USG Interiors, Inc.
3. Rockfon North America.
4. Or equal.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

2.3 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

- A. ACT -1 -Acceptable Product: Ultima Beveled Tegular (1942) by Armstrong World Industries (Location per plans and finish schedule)
1. Surface Texture: Fine.
 2. Composition: Mineral Fiber.
 3. Color: White.
 4. Size: 24" X 48" (24"x24" Look)
 5. Edge Profile: Beveled Tegular for interface with Superfine XL 9/16" Exposed Tee.
 6. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton, 0.80
 7. Ceiling Attenuation Class (CAC): ASTM C 1414; Classified with UL label on product carton, 35.
 8. Emissions Testing: Section 01350 Protocol, < 13.5 ppb of formaldehyde when used under typical conditions required by ASHRAE Standard 62.1-2004, "Ventilation for Acceptable Indoor Air Quality".
 9. Flame Spread: ASTM E 84; Class A (UL).
 10. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.88.
 11. Dimensional Stability: Standard -Space is enclosed, weatherproofed, HVAC systems operating.
 12. Antimicrobial Protection: BioBlock Plus - Resistance against the growth of mold/mildew and gram positive and gram-negative odor and stain causing bacteria.
- B. ACT -2 -Acceptable Product: Lyra Square Tegular (8731PB) by Armstrong World Industries (Location per plans and finish schedule)
1. Surface Texture: Smooth.

2. Composition: Mineral Fiber.
3. Color: White.
4. Size: 24" X 48" (24"x24" Look)
5. Edge Profile: Beveled Tegular for interface with Superfine XL 9/16" Exposed Tee.
6. Noise Reduction Coefficient (NRC): ASTM C 423; Classified 0.95
7. Ceiling Attenuation Class (CAC): ASTM C 1414; Classified, 42.
8. Emissions Testing: Section 01350 Protocol, < 13.5 ppb of formaldehyde when used under typical conditions required by ASHRAE Standard 62.1-2004, "Ventilation for Acceptable Indoor Air Quality".
9. Flame Spread: ASTM E 84; Class A (UL).
10. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.88.
11. Dimensional Stability: Standard -Space is enclosed, weatherproofed, HVAC systems operating.
12. Antimicrobial Protection: BioBlock Plus - Resistance against the growth of mold/mildew and gram positive and gram-negative odor and stain causing bacteria.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
- C. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 12 gauge (0.106") diameter.
- E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

- F. Angle Hangers: Angles with legs not less than 2 inch wide; formed with 0.04-inch- thick, galvanized steel sheet complying with ASTM A 653, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- 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 Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.
- J. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
- K. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.5 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

- A. Exposed Steel Suspension System: Formed galvanized steel, commercial quality cold rolled; heavy-duty.
 - 1. Product: Superfine XL by Armstrong, ICC# ESR 1308.
 - a. Profile: Tee; 9/16-inch-wide face.
 - b. Construction: Double web.
 - c. Structural Classification: ASTM C 635 Heavy-Duty.
 - d. Finish: Factory painted white.

2.6 METAL EDGE TRIM

- A. Extruded aluminum perimeter trim: As indicated on drawings. Same color and finish as that used for exposed flanges of suspension system runners.
 - 1. Product: Armstrong Axiom Classic Trim, 6" high Trim Channel

2.7 ACOUSTICAL SEALANT

- A. Comply with requirement of Division 7 "Joint Sealants".

PART 3 - EXECUTION

3.1 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.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with IR 25-2.13 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- 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, counters playing, 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 approved trapezes or equivalent devices.
 - 4. Where width of ducts and other construction within ceiling plenum interferes with location of required bracing and compression struts, install supplemental suspension members and hangers in form of approved trapezes or equivalent devices.
 - 5. 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.

6. Do not attach hangers to steel deck tabs.
 7. 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.
 8. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- 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 post installed 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, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. 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 a neat, precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 2. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 3. 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.
 4. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

3.4 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. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 10

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SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Resilient sheet flooring (RF-1)
- B. Static Dissipitive flooring (VCT-1)
- C. Resilient base (RB-1).
- D. Installation accessories.

1.2 RELATED SECTIONS

- A. None

1.3 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

1.4 SUBMITTALS

- A. See Division 01 Section, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

- C. Shop Drawings: Indicate seaming plan.
- D. Verification Samples: Submit two samples, 12 X 12 inch in size illustrating color and pattern for each resilient flooring product specified.
- E. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- G. Maintenance Materials: Furnish the following for University's use in maintenance of project.
 - 1. See Division 01 Section, for submittal procedures.
 - 2. Extra Wall Base: 25 linear feet of each type and color.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect roll materials from damage by storing on end.

1.6 FIELD CONDITIONS

- A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

1.7 REGULATORY REQUIREMENTS

- A. Resilient Flooring demonstrating a coefficient of friction of at least 0.6 per ASTM C1028 shall be accepted as meeting the intent of slip resistance. CBC Section 1124B.1.

PART 2 - PRODUCTS

2.1 SHEET FLOORING

- A. Linoleum Sheet Flooring (RF-1): Homogeneous wear layer bonded to backing, with color and pattern through wear layer thickness:

1. Minimum Requirements: Comply with ASTM F2034, Type corresponding to type specified.
2. VOC Content: Certified as Low Emission by one of the following:
3. Backing: Jute fabric.
4. Wear Layer Thickness: 0.080 inch, minimum, excluding backing.
5. Pattern: Solid color.
6. Seams: Heat welded.
7. Manufacturers:
 - a. Basis of Design: Tarkett Inc. Johnsonite: www.tarkett.com.
See Color Schedule on drawings
 - b. Armstrong World Industries, Inc: www.armstrong.com.
 - c. Forbo Linoleum, Inc; Product As indicated on Color Schedule: www.forbo-industries.com.
 - d. Substitutions: (Reference substitution requirements in Section 01 60 00).

2.2 STATIC DISSIPATIVE RESILIENT TILE FLOORING

- A. Static Dissipative Resilient Tile Flooring; Excelon CDT Vinyl Tile Flooring manufactured by Armstrong Flooring Inc
1. Collection: Excelon **SDT** Standard Colors
 2. Total Thickness: 1/8" (.125) inch minimum.
 3. Tile Size: 12"x12"
 4. Pattern:
 - a. Pattern and Color as indicated in the Finish Schedule and Finish Key Schedule of the Drawings, "**VCT-1**".
 5. Substitutions: (Reference substitution requirements in Section 01 60 00)

2.3 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove, and as follows:
1. Height: 4 inch.
 2. Thickness: 0.125 inch thick.
 3. Finish: Satin.
 4. Color: Color as selected from manufacturer's standards.
 5. Manufacturers:
 - a. Basis of Design: Roppe; Product as indicated on Color Schedule on drawings.
 - b. Acceptable Manufacturers that comply with these requirements:
 - 1) Burke Flooring: www.burkemercer.com.
 - 2) Johnsonite, Inc: www.johnsonite.com.

- 3) Substitutions: Reference substitution requirements in Division 01 Section.

2.4 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
 1. Provide only products having lower volatile organic compound (VOC) content than required by the South Coast Air Quality Management District Rule No. 1168.
- C. Moldings, Transition and Edge Strips: Same material as flooring.
- D. Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Verify that required floor-mounted utilities are in correct location

3.2 PREPARATION

- A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.3 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's instructions.

- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Resilient Strips: Attach to substrate using adhesive.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- I. Install flooring in recessed floor access covers, maintaining floor pattern.

3.4 SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Layout seams to avoid widths less than 1/3 of roll width; match patterns carefully at seams.
- B. Double cut sheet at seams.
- C. Lay flooring with tightly butted seams, without any seam sealer unless otherwise indicated.
- D. Finish seams in linoleum by heat welding.

3.5 RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.6 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.

- B. Clean in accordance with manufacturer's instructions.

3.7 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 65 00

SECTION 09 68 13 - CARPET TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes modular, carpet tile.
- B. Related Sections include the following:
 - 1. Division 9 Section "Resilient Flooring" for resilient wall base and accessories

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.
- B. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Existing flooring materials to be removed.
 - 3. Existing flooring materials to remain.
 - 4. Carpet tile type, color, and dye lot.
 - 5. Type of subfloor.
 - 6. Type of installation.
 - 7. Pattern of installation.
 - 8. Pattern type, location, and direction.
 - 9. Pile direction.
 - 10. Type, color, and location of insets and borders.
 - 11. Type, color, and location of edge, transition, and other accessory strips.
 - 12. Transition details to other flooring materials.

- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- long Samples.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- G. 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.
- H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

- C. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Provide glue down or firm cushion installation that complies with CBC section 11B-303.2
- E. Carpet shall have a level loop, textured loop, level-cut or level-cut/uncut pile texture and maximum pile height of ½" per CBC section 11B-303.2.
- F. Carpet edges shall comply with CBC section 11B-303.3.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.6 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- 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.

1.7 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
- B. Installer's Warranty: 1 year.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carpet Tile: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Mohawk (Basis of Design)
 - 2. Shaw Contract
 - 3. Or equal. See 01 60 00 for Substitution requirements

2.2 CARPET TILE

- A. Product: Mohawk Group.
 - 1. Collection: Expedition Collection
 - 2. Style Name: Gravitational Tile
 - 3. Color: Coastal GT343-955
 - 4. Product Type: Tile
 - 5. Construction: Textured Pattern loop
 - 6. Fiber: Duracolor Tricolor Premium Nylon with metallic Duracolor
 - 7. Protective treatments – EcoSentry Soil Protection
 - 8. Primary Backing: EcoFlex NXT
 - 9. Gauge: 1/12.
 - 10. Density: 6,315 cu. yd.
 - 11. Total Thickness: 0.226
 - 12. Stitches per Inch: 10.5/inch.
 - 13. Finished Pile Thickness: 0.114 inches
 - 14. Dye Method: Solution Dyed
 - 15. Pattern Repeat: Not Applicable
 - 16. Tufted Weight: 20.0 oz. per. Sq. yd.
 - 17. Size: 12"x36"
 - 18. Pattern Repeat: Not Applicable
 - 19. Tufted Weight: 20.0 oz. per. Sq. yd.

20. Size/Width: 24" x 24".
21. Installation Method: Glue Down
22. Indoor Air Quality: Green Label Plus GLP 1171
23. Foot Traffic Recommendation TARR: Severe
24. Flammability: ASTM E 648 Class 1 (Glue Down)
25. Flooring Radiant Panel Test: Meets NFPA Class 1 when tested under ASTM E-648 glue down
26. Smoke Density: ASTM E662 - Less than 450
27. Warranties:
 - a. Lifetime Limited Carpet Tile Warranty.
 - b. Lifetime Duracolor Stain Warranty.
 - c. Lifetime Static.
 - d. Lifetime Commercial Limited.

2.3 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, non staining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and as recommended/ required by the manufacturer for warrantee acceptance or provided by carpet tile manufacturer for the type of carpet being installed.
 1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D 5116:
 - a. Total VOCs: 10.00 mg/sq. m x h.
 - b. Formaldehyde: 0.05 mg/sq. m x h.
 - c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.

PART 3 - EXECUTION

3.1 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. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Substrates:

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- 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. 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 carpet tile manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Maintain dye lot integrity. Do not mix dye lots in same area.
- C. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosing's. Bind or seal cut edges as recommended by carpet tile manufacturer.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use non-permanent, non-staining marking device.

- F. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, 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 CRI 104, Section 16, "Protection of Indoor Installations."
- 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 09 68 13

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SECTION 09 70 00 - FIBER REINFORCED PLASTIC PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fiber reinforced plastic panel system (FRP-1) for adhesive mounting.
 - 2. Moldings, adhesive, and joint sealants.
- B. Related Sections:
 - 1. Division 9 Section "Gypsum Board."

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns. Include 2 sets of all trim pieces that the manufacturers provide in colors available.
- C. Maintenance Instructions.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
- B. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 4. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 5. Title 19 CCR, Public Safety, State Fire Marshall Regulations

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fiber reinforce plastic panels that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 years.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fiber Reinforced Plastic Panels: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Fiber Reinforced Plastic (FRP) panels by Marlite (Basis of Design)
 - 2. Kemlite.
 - 3. Glasteel.
 - 4. Kal-lite
 - 5. Or equal (Reference substitution requirements in Division 01 Section)

2.2 PANEL SYSTEM

- A. Plastic Panel System: Factory finished panels, trim, sealant, and accessories.
- B. Panels: Marlite FRP Panels; fiberglass reinforced polyester, USDA approved for incidental food contact.

1. Color and pattern to be: Standard FRP, pebbled texture selected by the Architect from the manufacturers standard colors.
 2. Surface Burning Characteristics: Flame spread index of 200 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E 84 (Class C/III).
 3. Surface Texture: Gently pebbled, high-gloss.
 4. Thickness: 3/32 inch, nominal.
 5. Width: 48 inches.
 6. Height: 96 inches
 7. Flexural Strength: 17,000 psi, when tested in accordance with ASTM D 790.
 8. Flexural Modulus: 600,000 psi, when tested in accordance with ASTM D 790.
 9. Tensile Strength: 8,000 psi, when tested in accordance with ASTM D 638.
 10. Tensile Modulus: 9,430 psi, when tested in accordance with ASTM D 638.
 11. Impact Resistance: 7 ft-lb/in, when tested in accordance with ASTM D 256, Izod method.
 12. Coefficient of Thermal Expansion: 0.0000157 in/in/degree F, measured in accordance with ASTM D 696.
 13. Water Absorption: 0.17 percent, when tested in accordance with ASTM D 570.
 14. Specific Gravity: 1.53, when tested in accordance with ASTM D 792.
- C. Panel Trim: Extruded PVC, in manufacturer's standard colors.
1. Outside corners, inside corners, edge trim, bottom (coved) trim for sealing tight to fixtures and division molding.
- D. Sealant: Marlite Silicone Sealant; gunnable silicone rubber; clear.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Take panels out of cartons and allow to acclimatize to room conditions for at least 48 hours prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Clean surfaces thoroughly prior to installation.

- D. Protect existing surfaces from damage due to installation.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use the adhesives recommended by the panel manufacturer unless prohibited by local regulations; obtain manufacturer's approval of alternative adhesives.
- C. Install continuous bead of silicone sealant in each joint and trim groove and between trim and adjacent construction, maintaining 1/8 inch expansion space.
- D. Avoid contamination of panel faces with adhesives, solvents, or cleaners; clean as necessary and replace if not possible to repair to original condition.
- E. Protect installed products until completion of project.
- F. Touch-up, repair or replace damaged products after Substantial Completion.

END OF SECTION 09 70 00

SECTION 09 91 00 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Surface Preparation.
 - 2. Field application of paints, stains, varnishes, and other coatings (PTG, PTS).
 - 3. See Schedules and Interior and Exterior Elevations on the Contract Documents for finished surfaces.
- B. Related Sections:
 - 1. Finish Schedule on the Contract Documents.

1.3 SUBMITTALS

- 1. Product data - Submit product data sheets for each product.
- 2. Samples:
 - a. Submit three painted samples (brush outs), illustrating selected colors and textures for each color and systems selected with specified coats cascaded.
 - b. Submit on suitable backing, 8x10 inch size.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Provide lighting level of 80 ft candles measured mid-height at substrate surface.
- C. Environment Requirements:
 - 1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be stored and applied.
 - 2. Stucco: Provide a PH test of the stucco that shows compliance with PH requirements of the paint manufacturer. Do not apply paint to stucco at PH levels over 10 or the max amount recommended by the paint manufacturer, whichever is less.
 - 3. Do not paint when there is a threat of rain within 24 hours or when surface or air temperatures are at or below 40 degrees.
 - 4. Architectural paints and coatings shall comply with VOC limits in Table 1 of the ARB Architectural Coatings Suggested Control measure, as shown in Table 5.504.4.3, unless more stringent local limits apply. The VOC Content limit for coatings that do not meet the definitions for specialty coatings categories listed in Table 5.504.4.3 shall be determined by classifying the coating as a Flat, Non-flat or non-flat high gloss coating based on its gloss, as defined in Subsections 4.21, 4.36 and 4.37 of the 2007 California Air Resources Board, suggested Control Measure, and the corresponding Flat, Non-flat or Non-flat-High gloss VOC limit on Table 5.504.4.3 shall apply. *"TABLE 5.504.4.3-VOC CONTENT LIMITS FOR ARCHITECTURAL COATINGS" (Cal Green Compliance)*
 - 5. Aerosol paints and coatings shall meet the PWMIR Limits for ROC in Section 94522(a)(3) and other requirements, including prohibitions on the use of certain toxic compounds and ozone depleting substances. In Sections 94522(c)(2) and (d)(2) of the California Code of Regulations, Title 17, commencing with Section 94520 and in areas under the jurisdiction of the Bay Area Air Quality Management District, (additionally) comply with the percent VOC by weight of product limits of Regulation 8 Rule 49. *"TABLE 5.504.4.3-VOC CONTENT LIMITS FOR ARCHITECTURAL COATINGS" (Cal Green Compliance)*

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace paint that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year.
- B. Installer Warranty: 1 year.

1.8 EXTRA STOCK

- A. Provide following with District's permission:
 - 1. Minimum 2 gallons of each product and each color in an original unopened or new 1 gallon cans.
 - a. Color spot each lid.
 - b. Identify with formula, location, product and date on the lid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Paints:
 - 1. Dunn-Edwards.
 - 2. Or equal (Reference substitution requirements in Division 01 Section)

2.2 PAINTS AND COATINGS

- A. Ready mixed, except field-catalyzed coatings.
- B. Prepare pigments:
 - 1. To a soft paste consistency, capable of being readily and uniformly dispersed to a homogenous coating.
 - 2. For good flow and brushing properties.
 - 3. Capable of drying or curing free of streaks or sags.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application. Do not proceed unless substrate is suitable.

- C. Test shop-applied primer for compatibility with subsequent cover materials.
- D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Plaster and Gypsum Wallboard: 12 percent.
 - 2. Interior Wood: 15 percent, measured in accordance with ASTM D-4442.
 - 3. Exterior Wood: 15 percent, measured in accordance with ASTM D-4442.

3.2 PREPARATION OF SURFACE

- A. General:
 - 1. Clean all exterior walls and surfaces of loose and scaly paint, dirt, dust, chalk, and other foreign matter by water-blasting using care not to damage substrate followed by hand scraping, sanding or wire brushing after surfaces are dry. Mildew must be treated with household bleach solution and rinsed thoroughly.
 - 2. Patch, caulk, set protruding nails and repair all surfaces and cracks where necessary with suitable patching materials and smooth off to match adjacent surfaces.
 - 3. Sand Glossy surfaces to dull surface and remove residue.
 - 4. Remove mildew from affected surfaces with a solution of Tri-Sodium Phosphate and bleach. Rinse with clean water and allow to dry completely.
 - 5. Existing surfaces to be recoated shall be thoroughly cleaned and de-glossed by sanding or other means prior to priming and painting. Patched and bare areas shall be spot primed with the same primer as specified for new work.
 - 6. Rusty metal: Scrape, sand or wire wheel, feathering edges to sound coating. Dust surfaces. Topcoat.
 - 7. Remove soil and body oils completely from surfaces, including handrails, door edges and posts. Treat with Liquid Sandpaper or Dull-N-Bond.
 - 8. Remove hardware, accessories, plates, fixtures and similar items not to be finished. Reinstall at completion.
 - 9. Paint edges of sink cut-outs.
- B. Galvanized Surfaces: Remove all oils and contamination from galvanized surfaces scheduled to be painted by washing with a compliant solvent wash.
- C. Ferrous Metal: Remove grease, rust, scale, dirt and dust from ferrous metal surfaces. Primer coat shall be applied not less than 30 minutes, nor more than 3 hours after preparation of surface.
- D. Primed Metal: Sand and scrape shop primed metal to remove loose primer and rust. Touch-up bare, abraded and damaged areas with metal primer. Feather edges to make touch-up patches inconspicuous.
- E. Wood Surfaces:
 - 1. Remove dust, grit and foreign matter from wood surfaces. Sand surfaces and dust clean. Spot prime knots, pitch streaks and sappy sections with a stain blocking primer where surfaces are to be painted. Fill nail holes, cracks and other defects after priming and spot prime repairs after patching material has fully cured.

2. Wood surfaces with peeling areas are to have edges of broken paint film sanded to a feather edge.
3. Back prime wood trim. Paint tops, bottoms, edges and cut-outs of doors.

F. Plaster Surfaces:

1. Plaster surfaces shall be dry and free from efflorescence, encrustations and foreign matter. Fill cracks, holes and imperfections, smoothing repairs to match adjacent texture. Allow repairs to fully cure before priming.
2. Prime plaster surfaces with specified primer. Caulk all cracks.

G. Gypsum Board: Gypsum board shall be dusted clean and free from encrustations and other foreign matter.

H. Preparation of other surfaces shall be performed following specific recommendations of the coating manufacturer.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

D. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless otherwise approved

E. Sand wood surfaces lightly between coats to achieve required finish.

F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust particles just prior to applying next coat.

G. Stipple all edges and corners to conceal brush marks.

H. Doors: Paint entire door unless otherwise noted, including door top and bottom edge surfaces.

I. Paint entire trim element. Painting of faces only is unacceptable. Trim surfaces must be wrapped with the trim color and not "faced off" or "Hollywooded".

J. Tinting: Tint each primer a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint primer to match the color of the finish coat, but provide sufficient differences in shade of primer to distinguish each separate coat.

- 1) Primer 25%
- 2) 1st coat 50% Finish
- 3) 2nd coat 100% Finish
- 4) Sequence of work should meet approved draw down cards submitted per Section 1.3 Submittals.

- 5) 5) Each coat shall be inspected prior to application of following coat by Inspector of Record.

3.4 PROTECTION

- A. Protect work of other trades and items not intended to receive paint. Install "wet paint" signs to protect newly painted surfaces.

3.5 CLEANING

- A. Protection - Carefully protect areas where work is in progress from damage.
 1. Provide and spread clean drop cloths when and where required to provide the necessary protection.
 2. Immediately clean-up all accidental spatter, spillage, misplaced paint and restore the affected surface to its original condition.
- B. Clean-up:
 1. At completion of work, remove all materials, supplies, debris and rubbish and leave each area in a clean, acceptable condition.
 2. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.6 SURFACES TO BE FINISHED

- A. Paint all new work and areas affected by new work, unless noted otherwise.
- B. Do not paint or finish the following items:
 1. Items fully factory-finished unless specifically noted.
 2. Fire rating labels, equipment serial number and capacity labels.
- C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
 1. Paint all insulated and exposed pipes occurring in finished areas to match background surfaces, unless otherwise indicated.
 2. Paint shop primed items occurring in finished areas.
 3. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint.
 4. Paint dampers exposed behind louvers, grilles and convector and baseboard cabinets to match face panels.

3.7 EXTERIOR PAINT SCHEDULE (SOURCE CAL POLY PAINT STANDARD DATED MAY 2022)

1. Concrete, Stucco and Masonry (Other than Concrete Masonry Units): Provide the following finish systems over exterior concrete, stucco and brick masonry surfaces:

1st Coat : Dunn Edwards Superloc Int/Ext Masonry/Bonding primer (SLPR00) 2nd Coat :
Dunn Edwards Evershield Exterior Eggshell Paint (EVSH30)
3rd Coat : Dunn Edwards Evershield Exterior Eggshell Paint (EVSH30)

OR

1st Coat : Loxon Int/Ext Acrylic Masonry Primer (A24W8300) 2nd Coat :
Super-Paint Exterior Acrylic Satin Enamel (A89W1151) 3rd Coat : Super-
Paint Exterior Acrylic Satin Enamel (A89W1151)

2. Concrete Masonry Units: Provide the following finish systems over exterior concrete masonry units:

1st Coat : Dunn Edwards Premium Smooth Blocfil Int/Ext (SBPR00) 2nd Coat :
Dunn Edwards Evershield Exterior Eggshell Paint (EVSH30) 3rd Coat : Dunn
Edwards Evershield Exterior Eggshell Paint (EVSH30)

OR

1st Coat : Heavy Duty Int/Ext Acrylic Block Filler (B42W46)
2nd Coat : Super-Paint Exterior Acrylic Satin Enamel (A89W1151) 3rd Coat :
Super-Paint Exterior Acrylic Satin Enamel (A89W1151)

3. Wood: Provide the following semi-transparent stain finish system over exterior wood:

1st Coat : Old Masters Ascend Exterior Waterbed Clear Finish - Satin (OM-71101-1) 2nd Coat :
Old Masters Ascend Exterior Waterbed Clear Finish - Satin (OM-71101-1)

OR

1st Coat : Woodscapes Waterbase Polyurethane Semi-Transparent Stain (A15T5) 2nd Coat :
Woodscapes Waterbase Polyurethane Semi-Transparent Stain (A15T5)

4. Wood: Provide the following solid color stain finish system over exterior wood:

1st Coat : Dunn Edwards Acri-hues Exterior Flat (ACHS10) 2nd Coat :
Dunn Edwards Acri-hues Exterior Flat (ACHS10)

OR

1st Coat : Woodscapes Exterior Acrylic Solid Color Stain (A15W51) 2nd
Coat : Woodscapes Exterior Acrylic Solid Color Stain (A15W51)

5. Wood: Provide the following paint system over exterior wood surfaces:

1st Coat : Dunn Edwards Ultra-grip Premium Int/Ext Primer (UGPR00) 2nd
Coat : Dunn Edwards Evershield Exterior Eggshell Paint (EVSH30) 3rd Coat :
Dunn Edwards Evershield Exterior Eggshell Paint (EVSH30)

OR

1st Coat : Multi purpose Int/Ext Acrylic Primer (B51W450)
2nd Coat : Super-paint Exterior Acrylic Satin Enamel (A89W1151) 3rd Coat :
Super-paint Exterior Acrylic Satin Enamel (A89W1151)

6. Ferrous Metal: Provide the following finish system over exterior ferrous metal (primer is not required on shop-primed items):

- 1st Coat : Dunn Edwards Endura-prime Int/Ext Rust Preventative Metal Primer (ENPR00)
- 2nd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss (ENCT30 or ENCT50)
- 3rd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss (ENCT30 or ENCT50)

OR

- 1st Coat : Pro-Cryl Universal Acrylic Metal Primer (B66W310)
- 2nd Coat : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651) 3rd Coat.
: Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651)

7. Zinc-coated Metal: Provide the following finish system over exterior zinc-coated (galvanized metal) surfaces:

- 1st Coat : Dunn Edwards Ultrashield Galvanized Metal Primer (ULGM00)
- 2nd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss (ENCT30 or ENCT50)
- 3rd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss (ENCT30 or ENCT50)

OR

- 1st Coat : Pro-Cryl Universal Acrylic Metal Primer (B66W310)
- 2nd Coat : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651) 3rd Coat.
: Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651)

8. Aluminum: Provide the following finish system over exterior aluminum surfaces:

- 1st Coat : Dunn Edwards Ultrashield Galvanized Metal Primer (ULGM00)
- 2nd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss (ENCT30 or ENCT50)
- 3rd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss (ENCT30 or ENCT50)

OR

- 1st Coat : Pro-Cryl Universal Acrylic Metal Primer (B66W310)
- 2nd Coat : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651) 3rd Coat.
: Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651)

IF ANY SURFACE IS NOT LISTED ABOVE, PLEASE REACH OUT TO GET RECOMMENDATION

3.8 INTERIOR PAINT SCHEDULE (SOURCE CAL POLY PAINT STANDARD DATED MAY 2022)

1. Concrete and Masonry (other than Concrete Masonry Units): Provide the following paint system over interior concrete and brick masonry surfaces:

1st Coat : Dunn Edwards Superloc Int/Ext Masonry/Bonding primer (SLPR00) 2nd Coat :
Dunn Edwards Everest Interior Eggshell Paint (EVER30)
3rd Coat : Dunn Edwards Everest Interior Eggshell Paint (EVER30)

OR

1st Coat : Loxon Int/Ext Acrylic Masonry Primer (A24W8300) 2nd Coat :
Super-Paint Interior Acrylic Satin Enamel (A87W1151) 3rd Coat : Super-
Paint Interior Acrylic Satin Enamel (A87W1151)

2. Concrete Masonry Units: Provide the following finish systems over interior concrete masonry units:

1st Coat : Dunn Edwards Premium Smooth Blocfil Int/Ext (SBPR00) 2nd
Coat : Dunn Edwards Everest Interior Eggshell Paint (EVER30) 3rd Coat :
Dunn Edwards Everest Interior Eggshell Paint (EVER30)

OR

1st Coat : PrepRite Int/Ext Acrylic Block Filler (B25W25)
2nd Coat : Super-Paint Interior Acrylic Satin Enamel (A87W1151) 3rd
Coat : Super-Paint Interior Acrylic Satin Enamel (A87W1151)

3. Gypsum Board - Flat finish on ceilings: Provide the following finish systems over interior gypsum board ceiling surfaces:

1st Coat : Dunn Edwards Ultra-grip Premium Int/Ext Primer (UGPR00) 2nd
Coat : Dunn Edwards Acri-Wall Flat Zero VOC Paint (ACWL10) 3rd Coat : Dunn
Edwards Acri-Wall Flat Zero VOC Paint (ACWL10)

OR

1st Coat : Premium Interior Acrylic Wall & Wood primer (B28W8111) 2nd
Coat : Pro Mar 400 Zero VOC Interior Acrylic Flat (B30W4651) 3rd Coat : Pro
Mar 400 Zero VOC Interior Acrylic Flat (B30W4651)

4. Gypsum Board - Satin Finish: Provide the following finish system over interior gypsum board:

1st Coat : Dunn Edwards Ultra-grip Premium Int/Ext Primer (UGPR00) 2nd Coat
: Dunn Edwards Everest Interior Eggshell Paint (EVER30)
3rd Coat : Dunn Edwards Everest Interior Eggshell Paint (EVER30)

OR

1st Coat : Premium Interior Acrylic Wall & Wood primer (B28W8111) 2nd
Coat : Super-Paint Interior Acrylic Satin Enamel (A87W1151) 3rd Coat :
Super-Paint Interior Acrylic Satin Enamel (A87W1151)

5. Gypsum Board - Semi-gloss Finish: Provide the following finish system over interior gypsum board:

1st Coat : Dunn Edwards Ultra-grip Premium Int/Ext Primer (UGPR00) 2nd Coat : Dunn Edwards Everest Interior Semi-gloss Paint (EVER50) 3rd Coat : Dunn Edwards Everest Interior Semi-gloss Paint (EVER50)

OR

1st Coat : Premium Interior Acrylic Wall & Wood primer (B28W8111) 2nd Coat : Super-Paint Interior Acrylic Semi-gloss Enamel (A88W1151) 3rd Coat : Super-Paint Interior Acrylic Semi-gloss Enamel (A88W1151)

6. Wood - Paint Grade: Provide the following paint finish system over new interior wood surfaces:

1st Coat : Dunn Edwards Ultra-grip Premium Int/Ext Primer (UGPR00) 2nd Coat : Dunn Edwards Everest Interior Semi-gloss Paint (EVER50) 3rd Coat : Dunn Edwards Everest Interior Semi-gloss Paint (EVER50)

OR

1st Coat : Premium Interior Acrylic Wall & Wood primer (B28W8111) 2nd Coat : Pro Classic Interior Acrylic Semi-gloss Enamel (B31W1151) 3rd Coat : Pro Classic Interior Acrylic Semi-gloss Enamel (B31W1151)

7. Wood - Stain Grade: Provide the following stain finish system over new interior wood surfaces:

1st Coat : Old Masters Int/Ext Oil stain 2nd Coat : Old Masters Sanding Sealer 3rd Coat : Old Masters Masters Armor - Satin (OM-72101-1) 4th Coat : Old Masters Masters Armor - Satin (OM-72101-1)

OR

1st Coat : Wood Classics Interior Oil Stain (A49T804) 2nd Coat : Zar Ultra Max Waterborne Oil Modified Sanding Sealer 3rd Coat : Zar Ultra Max Interior Waterborne Oil Modified Polyurethane Varnish - Satin 4th Coat : Zar Ultra Max Interior Waterborne Oil Modified Polyurethane Varnish - Satin

8. Ferrous Metal: Provide the following paint finish system over interior ferrous metal:

1st Coat : Dunn Edwards Endura-prime Int/Ext Rust Preventative Metal Primer (ENPR00) 2nd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi-gloss (ENCT30 or ENCT50) 3rd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi-gloss (ENCT30 or ENCT50)

OR

1st Coat : Pro-Cryl Universal Acrylic Metal Primer (B66W310) 2nd Coat : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651) 3rd Coat : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651)

9. Zinc-coated Metal: Provide the following finish system over interior zinc-coated (galvanized metal) surfaces:

1st Coat : Dunn Edwards Ultrashield Galvanized Metal Primer (ULGM00)

2nd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss
(ENCT30 or ENCT50)

3rd Coat : Dunn Edwards Endura-Coat Int/Ext DTM Acrylic Eggshell Paint or Semi- gloss
(ENCT30 or ENCT50)

OR

1st Coat : Pro-Cryl Universal Acrylic Metal Primer (B66W310)

2nd Coat : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651) 3rd

Coat. : Pro Industrial HP Acrylic Eggshell or Semi-gloss Paint (B66W651)

IF ANY SURFACE IS NOT LISTED ABOVE, PLEASE REACH OUT TO GET RECOMMENDATION

3.9 COLORS

- A. To be selected by Architect from Manufacturers standard color palette and as scheduled on the "Finish Schedule" provided in the plans. All Colors shall be accepted by the Cal Poly Project Manager prior to Architect Approval of sample "draw downs" and ordering

END OF SECTION 09 91 00

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SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Panel signs (room signs)
 - 2. Parking signs.
 - 3. Traffic signs.
 - 4. Signage accessories

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.
- B. Shop Drawings: Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.
 - 1. Provide message list for each sign, including large-scale details of wording, lettering, artwork, and braille layout.
- C. Samples for Initial Selection: For each type of sign material indicated that involves color selection.
- D. Samples for Verification: For each type of sign, include the following Samples to verify color selected:
 - 1. Panel Signs: Full-size Samples of each type of sign required.
 - 2. Approved samples will not be returned for installation into Project.
- E. Qualification Data: For Installer.
- F. Maintenance Data: For signage cleaning and maintenance requirements to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
- B. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 - 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 - 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 - 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 - 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 - 6. 2019 California Energy Code, Part 6, Title 24 CCR
 - 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 - 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 - 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 - 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations
- C. Installer Qualifications: An authorized representative of signage manufacturer for installation and maintenance of units required for this Project.
- D. Source Limitations: Obtain each sign type through one source from a single manufacturer.
- E. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.
- F. Inspection Requirement: Tactile signs shall be field inspected for compliance after installation. [CBC 11B-703.1.1.2]

1.5 PROJECT CONDITIONS

- A. Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

- A. For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.
 - 1. For signs supported by or anchored to permanent construction, furnish templates for installation of anchorage devices.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signage fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year.
- B. Installer Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Signs: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Best Sign Systems Inc. (Basis of Design)
 - 2. ASI Sign Systems, Inc.
 - 3. Mohawk Sign Systems.
 - 4. Sign A Rama.
 - 5. Or equal (Reference substitution requirements Division 01 Section)
 - 6. All room signs shall be installed per the University Standard and to be provided and installed by "The Sign Place", San Luis Obispo, CA.

2.2 PANEL SIGNS

- A. General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
 - 1. Produce smooth panel sign surfaces constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 inch measured diagonally.
- B. Product: HC300 ADA Sign System by Best Sign Systems.
 - 1. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished.
 - 2. Room: All room signs shall be installed per the University Standard Design, to be provided and installed by "The Sign Place", San Luis Obispo, CA.
 - 3. Toilet Room Signs: As selected from manufacturer's standard 6" x 8".
 - 4. Wayfinding Signs shall be 6" X 8"
 - 5. Symbols of Accessibility: Provide 6-inch- high symbol fabricated from opaque nonreflective vinyl film, 0.0035-inch nominal thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.
 - 6. Material:

- a. 1/4 inch thick (thicker than standard) "MP", acrylic sheet, ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
7. Tactile and Braille Copy: Manufacturer's standard process for producing copy complying with ADA Accessibility Guidelines and ICC/ANSI A117.1. Text shall be accompanied by California Contracted Grade 2 Braille raised domed dots. Produce precisely formed characters with square cut edges free from burrs and cut marks, use dome dots. Grade 2 Braille shall be placed directly below last line of letters or numbers, except for room number signs, where they shall be placed directly behind the last number.
8. Raised characters shall comply with CBC 11B-703.2 and Braille shall comply with 11B-703.3.
9. Copy: 5/8 inch Helvetica Medium with contracted grade 2 Braille.
10. Corners shall be 1/2" radius
11. Colors: As selected from full range of standard colors by Architect..

2.3 PARKING SIGNS

- A. Material: 0.063" aluminum, screen printed copy on engineer grade reflective vinyl sheeting.
 1. Text: Symbols of accessibility, accessible direction, etc. as indicated on Drawings.
- B. Accessible signs are blue with white symbol.
- C. Post: 2 inch diameter, schedule 40 galvanized pipe.

2.4 TRAFFIC SIGNS

- A. Material: 0.080" aluminum, screen printed copy on engineer grade reflective vinyl sheeting.
 1. Text: Stop, Yield, Do Not Enter, etc. as indicated on Drawings.
- B. Post: 2 inch diameter, schedule 40 galvanized pipe.

2.5 ACCESSORIES

- A. Mounting Methods: Use concealed fasteners fabricated from materials that are not corrosive to sign material and mounting surface.
- B. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.6 FINISHES, GENERAL

- 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 strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items, including anchor inserts, provided under other sections of Work are sized and located to accommodate signs.
- C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions.
 - 1. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.
 - 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.

3. Where signs are to be installed on glass use double sided tape. Provide vinyl plastic film in an opaque color, size to match sign, color as selected by Architect to match sign colors. Install on backside/ opposite side of glass from tape to hide the tape from view.

B. Wall-Mounted Panel Signs:

1. Exterior and Interior Signs on Rough Substrates:
 - a. Mechanical Fasteners: Mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
 - 1) Fastener: Stainless steel screws, tamper-resistant flat head countersink.
 - 2) Anchors: Suitable for secure attachment to substrate.

C. Parking and Traffic Signs

1. General: Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with the manufacturer's instructions and details noted on plans.
2. Install sign level, plumb, and at height indicated.
3. Cap post with galvanized cap.

3.3 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION 10 14 00

SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes solid-polymer units as follows:
 - 1. Toilet Enclosures: Overhead braced and floor anchored.
 - 2. Urinal Screens: Wall hung.
- B. Related Sections include the following:
 - 1. Division 6 Section "Steel Stud Framing" for blocking.
 - 2. Division 10 "Toilet and Bath Accessories" for toilet tissue dispensers, grab bars, shelves, and similar accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of cutouts for compartment-mounted toilet accessories.
 - 2. Show locations of reinforcements for compartment-mounted grab bars.
- C. Samples for Initial Selection: For each type of unit indicated.
- D. Samples for Verification: Of each type of color and finish required for units, prepared on 6-inch- square Samples of same thickness and material indicated for Work.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR

2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations
11. NFPA 286 compliant.

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- B. ASTM International:
1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 2. ASTM D 1735 - Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
 3. ASTM D 2247 - Standard Practice for Testing Water Resistance of Coatings in 100 percent Relative Humidity

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating toilet compartments without field measurements. Coordinate wall, floor, ceilings, and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

1.6 WARRANTY

- A. Manufacturer's standard 15-year warranty.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Solid-Polymer Units: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Scranton Products (Hiny Hiders)
 - 2. Or approved equal products (Refer to substitution requirements in Section 01 60 00)

2.2 MATERIALS

- A. Solid-Polymer: Solid, homogenous HDPE; 1 inch thick.
- B. Aluminum: 6063-T5 aluminum extrusions, ASTM B221.

2.3 SOLID-POLYMER UNITS

- A. Door, Panel, and Pilaster Construction: Single sheet solid, homogenous HDPE plastic material formed from waterproof, non-absorbent, high-density polyethylene resins; mark-resistant self-lubricating surface; edges finished smooth.
 - 1. Material: Solid, homogenous HDPE; 1 inch (25 mm) thick.
 - 2. Rating: Class "B" Fire Rated per ASTM E 84.
 - 3. Edges: 1/4 inch (6 mm) radius machined edges.
 - 4. Heat Sink: Aluminum heat sink, to dissipate heat from incendiary devices used by vandals, attached to bottom of doors and panels.

2.4 COMPONENTS

- A. Wall and Pilaster Brackets: 54-inch long, continuous plastic channel brackets.
- B. Pilaster Shoes:
 - 1. Manufacturer's standard design; one-piece design and integral to the mounting system from #304 stainless steel 3" high with a #4 satin finish.
- C. Head Rail:
 - 1. Heavy-duty anodized extruded aluminum (6063-T5 alloy).
 - 2. Head rail is anti-grip and attaches to the top of the pilaster with stainless steel, tamper-resistant screws.

- D. Fasteners: Manufacturer's standard, stainless steel theft resistant barrel nuts and shoulder screws.
- E. Mounting Brackets: Provide optional aluminum continuous bracket with theft resistant barrel nuts and shoulder screws.
- F. Hardware:
 - 1. Hinge Type: Continuous cam action stainless steel piano hinge. Holds door in a partially Open or closed position when at rest.
 - 2. Door latch: Surface mounted. Non-ferrous, brushed chrome plated finish.
 - 3. Strike and keeper: Brushed chrome-plated finish. Provides emergency access by lifting door.
 - 4. Coat Hook and Bumper: Non-ferrous, chrome plated, with black rubber tip for door stop.
 - 5. Hinge Inswing: Standard position closed.
 - 6. Hinge Outswing (ADA): Standard position closed.
 - 7. Hinge Accessible: Standard position closed.
 - 8. Equip outswing handicapped doors with second door pull and door stop.

2.5 FABRICATION

- A. Toilet Compartment Doors, Panels and Pilasters:
 - 1. Compartment Depth and Width: As scheduled and indicated on Drawings.
 - 2. Door Width:
 - a. 24 inches minimum.
 - b. ADA Accessible:
 - 1) Front Access to Compartment: 33 inches minimum clear opening.
 - 2) Side Access to Compartment: 35 inches minimum clear opening.
 - 3. Door/Panel Height: 58 inches.
 - 4. Pilaster Height: 82 inches.
 - 5. Panel Height: 55 inches, mounted 12 inches AFF.
 - 6. Heat-Sink Strip: Aluminum edging strips to be fastened to bottom edge of doors and panels using anti-theft fasteners.
- B. Urinal Screens:
 - 1. Thickness: 1 inch.
 - 2. Screen Width: 24 inches minimum.
 - 3. Screen Height: 42 inches mounted 12 inches AFF.
 - 4. Heat-Sink Strip: Aluminum edging strips to be fastened to bottom edge of doors and panel using anti-theft fasteners.

2.6 FINISHES

- A. Solid, high-density polyethylene:
 - 1. Colors: Pebble-textured homogenous color throughout material. Color as selected from manufacturer's standard colors.
- B. Aluminum: Clear anodized.
- C. Stainless Steel: Brushed/ Satin

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels or Pilasters and Walls: 1-1/2 inch.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less than two fasteners. Hang doors to align tops of doors with tops of panels and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. 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.
- D. Wall-Hung Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ERECTION TOLERANCES

- A. Maximum variation from true position: 1/4 inch. Clearance at vertical edges of doors shall be uniform top to bottom and shall not exceed 1/4 inch.
- B. Maximum variation from plumb: 1/8 inch.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to 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 10 21 13

10 22 26 MOVABLE WALL SYSTEM

PART 1 – GENERAL SPECIFICATIONS

1.01 WORK INCLUDED

- A. Operable Wall System shall be furnished, installed and serviced by wall manufacturer's authorized distributor, in compliance with the architectural drawings and specifications contained herein.

1.02 RELATED WORK

- A. Structural Support: Structural support system required for suspending the operable wall shall be designed, installed and pre-punched by others, in accordance with ASTM E 557 and manufacturer's shop drawings.
- B. Insulation: Sound insulation and baffles for the plenum area above the track system, under the permanent floor, inside air ducts passing over or around the operable wall, and in permanent walls adjoining the operable wall system shall be by others, in accordance with ASTM E 557.
- C. Opening Preparation: Proper and complete preparation of the operable wall system opening shall be by others in accordance with ASTM E 557, and shall include floor leveling; plumbness of adjoining permanent walls; substrate and/or ceiling tile enclosures for the track system; and the painting and finishing of trim and other materials adjoining the head and jamb areas of the operable wall. Any permanent wall(s) receiving an adjustable or fixed wall jamb will require internal structural blocking in order to secure the jamb to the permanent wall. Refer to a copy of the shop drawings for additional details.

1.03 SYSTEM DESCRIPTION

- A. The operable wall system shall consist of Individual Panels that are top supported by two (2) multi-directional carriers that are capable of negotiating 90° "X", "L" and "T" intersections.
- B. The operable wall system shall consist of acoustically rated panels tested in accordance with ASTM E 90 and ASTM E 413 test procedures, and shall have achieved a STC rating as specified herein (see "Acoustical Performance" article listed under Part 2 – Products).

1.04 QUALITY ASSURANCE

- A. The operable wall shall have been tested in an independent acoustical testing laboratory in accordance with ASTM E 90 and ASTM E 413 test procedures.

- B. The operable wall panel construction and finish materials shall consist of Class A rated materials in accordance with ASTM E 84.
- C. The operable wall shall be installed by the manufacturer's authorized distributor in accordance with ASTM E 557.

1.05 REFERENCES

- A. ASTM E 90: Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions.
- B. ASTM E 413: Determination of Sound Transmission Class (STC).
- C. ASTM E 557: Architectural Application and Installation of Operable Partitions.
- D. ASTM E 84: Surface Burning Characteristics of Building Materials.
- E. ASTM A 653: Specification for General Requirements for Steel Sheet, Alloy-Coated (Galvannealed) by the Hot Dip Process.
- F. ASTM C 423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- G. CCC-W-408A: Federal Specification which applies to Vinyl Coated Wall Coverings.
- H. CFFA-W-101-D: Chemical Fabrics and Film Association Quality Standard for Vinyl Coated Fabric Wall Coverings.

1.06 SUBMITTALS

- A. Manufacturer shall provide written technical information and related detail drawings, which demonstrate that the products comply with contract documents for each type of operable partition specified.
- B. Manufacturer shall provide detailed engineering drawings featuring track plan, panel elevation, horizontal and vertical details and beam punching template as required.
- C. Manufacturer shall provide written test report of the independent acoustical testing laboratory certifying the attainment of the specified STC rating, upon request.
- D. Manufacturer shall provide written instructions specifying the proper operation and maintenance of the operable wall system.

- E. Manufacturer shall provide a color selector demonstrating the manufacturer's selections of the specified finish material. Samples shall consist of actual swatches of the specified finish material.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Panels shall be individually wrapped in a protective plastic covering to keep panels clean during delivery, storage and handling.
- B. Panels shall be stored on edge and above the floor on cushioned blocking in a dry and ventilated area, protected from humidity and temperature extremes.

1.08 SEQUENCING / SCHEDULING

- A. Beam Punching: Manufacturer shall provide beam punching template drawing detailing the anchor locations for the suspended track system (as required for Drop Rod Mounting), as required for the fabrication and installation of structural overhead support by others.
- B. Track Installation: Scheduling of operable wall track installation shall occur after structural overhead support has been properly and completely fabricated and installed by others.
- C. Panel Installation: Operable wall panel installation shall occur after fixed wall substrate construction is properly and completely installed by others, as required to protect panels from ongoing adjacent construction.

1.09 WARRANTY

Manufacturer shall warrant each operable wall panel and its component parts to be free from defects in material and workmanship for a period of five (5) years from the date of delivery to the original purchaser, when installed by an authorized KWIK-WALL distributor. KWIK-WALL also warrants the fixed top seals, track, carriers, and its component parts to be free from defects in material and workmanship for a period of ten (10) years. (Contact your local KWIK-WALL Distributor or KWIK-WALL Company for complete warranty information.)

PART 2 – PRODUCT SPECIFICATIONS

2.01 ACCEPTABLE MANUFACTURER

- A. Operable walls shall be Series 3000, Model 3020 Individual Panels / Multi-Directional as manufactured by KWIK-WALL Company.

2.02 PANEL CONSTRUCTION

- A. Panel Dimensions: Standard panel dimension shall be a nominal 4" [101.6] thick.
- B. Panel Frame: Steel frame shall be 16-gauge galvanized steel, horizontal top cross member shall be minimum 12-gauge galvanized steel which meets or exceeds ASTM A 653 requirements. Frame shall be all-welded construction with steel corner supports and cross-bracing reinforcement. Panel frame shall be Class A rated, fire retardant, non-combustible and non-corrosive in accordance with ASTM E 84.
- C. Panel Skins: Panel skins shall be Class A rated (except Wood Veneer and High Pressure Laminate) in accordance with ASTM E 84. Panel skin material shall consist of (select):
1. *Standard Steel Skins*: consisting of minimum 22-gauge tension-leveled galvanized steel, pressure laminated to a structural acoustical backer and mechanically-joined to the steel frame to form a rigid, unitized and structural panel.
 2. *Optional Acoustical Substrate*: consisting of structural acoustical substrate pressure laminated to both sides of the steel frame to form a rigid, unitized and structural panel.
 3. *Optional Wood Veneer*: consisting of particle board core covered with wood veneer and pressure laminated to both sides of the steel frame to form a rigid, unitized and structural panel.
 4. *Optional High Pressure Laminate*: consisting of gypsum board core covered with general purpose plastic laminate and Phenolic backer sheet, which is pressure laminated to both sides of the steel frame to form a rigid, unitized and structural panel.
- D. Panel Weight: Maximum panel weight shall be 5.9 – 12.9 lb./ft.² (29 – 63 kg/m²) depending on STC rating, size and options selected.

2.03 OPERATION

- A. Operation shall be Individual Panels with a Multi-Directional track system that allows the panels to negotiate 90° "X", "L" and "T" intersections as required for movement of panels from storage location(s) to various installed positions. Panels shall be top supported by two (2) carriers featuring dual horizontal precision bearings with high strength polymer tires riding on a structural aluminum track.

2.04 STACK ARRANGEMENTS

- A. Stack Type: Panel storage configuration shall be (select):
1. *Standard Perpendicular Stack*: consisting of panels stacked perpendicular to the wall's installed position.
 2. *Optional Parallel Stack*: consisting of panels stacked parallel to the wall's installed position.

3. *Optional Remote Stack*: consisting of panels located remotely from the wall's installed position, as shown on submitted shop drawings.

B. Stack Quantity: Panels shall be stored in separate stack areas as required for panel storage.

2.05 FINISHES

A. Finish Material Type: Panel finish material shall be Class A (except wood veneer and high pressure laminate) rated in accordance with ASTM E 84, consisting of (select):

1. *Vinyl*: consisting of Type II, reinforced vinyl weighing 21 oz./lin. yd. (651 g/lin. m). Vinyl shall meet or exceed CCC-W-408A and CFFA-W-101-D quality standards.

B. Finish Material Supplier: Finish material shall be (select):

1. *Standard Factory Supplied*: from manufacturer's standard selection of finish materials, as specified.

C. Finish Material Application: Finish material shall be (select):

1. *Standard Factory Applied*: by operable wall manufacturer. Customer supplied finish material samples must be submitted to manufacturer for testing and approval prior to acceptance and application.

2.06 PERIMETER TRIM AND SEALS

A. Vertical Trim and Seals: Panels shall have vertical astragals containing flexible vinyl seals and incorporate reversible tongue-and-groove-type configurations for positive interlocking with adjacent panels. Vertical astragal type shall be (select):

1. *Standard Trimless Astragal*: consisting of an aluminum extrusion with tongue-and-groove-type vertical astragals. Vertical trim shall not be permitted on the panel faces, resulting in a minimal groove appearance between adjacent panels.

B. Horizontal Top Trim and Seals: Top seals shall consist of flexible vinyl sweep seals installed on both sides of the panel. The seals shall consist of a compressed bulb between two (2) fingers of vinyl. Top seal type shall be (select):

1. *Standard Fixed Top Seals*: consisting of continuous-contact flexible vinyl sealing against the bottom flange of the overhead track.

C. Horizontal Bottom Trim and Seals: Bottom seals shall consist of multiple fingers of flexible vinyl for positive contact and sealing with various floor surfaces. Bottom seal type shall be (select):

1. *Standard Operable Bottom Seals*: consisting of an edge-activated seal using a removable wrench as supplied by manufacturer. Bottom seals shall provide 2" [50.8] of nominal travel.
- D. Horizontal and Vertical Panel Trim: All exposed panel trim and hinges shall be of one (1) similar color (select):
 1. Dark Bronze.
 2. Grey.

2.07 CLOSURE SYSTEMS

- A. Initial Closure System: The lead panel (the first panel exiting the stack) shall form a seal vertically against a rigid wall surface, as accomplished by a (select):
 1. *Standard Bulb Seal*: consisting of continuous-contact, flexible vinyl bulb seals installed along the vertical edge of the lead panel for positive compression against a rigid wall surface.
- B. Final Closure System: The final closure panel (the last panel exiting the stack) shall form a seal vertically against a rigid wall surface. The type of final closure panel shall be (select):
 1. *Standard Expander Panel Closure*: consisting of an expander mechanism with a nominal 5" [127] of travel, activated from the face of the panel using a removable wrench as supplied by manufacturer. The Expander Panel shall be equipped with an adjustable bottom seal (standard) or (optional) operable bottom seal, and a flush pull handle.

2.08 ACOUSTICAL PERFORMANCE

- A. Certification: The operable wall shall have been tested in an independent acoustical testing laboratory in accordance with ASTM E 90 and ASTM E 413 test procedures.
- B. STC Rating: The operable wall acoustical performance rating shall be based on (select):
 1. *Standard Steel Skins*: with a standard rating of 52 STC, or optional ratings of 46 STC, 50 STC or 56 STC.
(Note: Not available with optional Wood Veneer or High Pressure Laminate.)

2.09 PANEL ACCESSORIES

- A. Accessories including Pass Doors; Single or Double, Keyed Cylinder Locks, Concealed Door Closures, Room Viewers, Exit Signs, Dry Marker Writing Surfaces, Recessed Eraser Trays, Vision Lites, Tack Surfaces and Pocket Doors shall be compatible with other accessories and options, furnished and installed by the operable wall manufacturer as noted on submitted shop drawings.

2.10 TRACK SYSTEMS

- A. Track Type: The operable wall track system shall be extruded from structural aluminum alloy, which prohibits deterioration caused by rust or corrosion. The aluminum track shall have a durable anodized clear satin finish, which resists color fading and flaking. The track shall utilize grooves and interlocking steel pins for positive alignment of adjacent track sections. The track joints shall be reinforced overhead by a heavy-duty steel bracket made of hot-rolled, 3/8" [10] thick plate steel. Aluminum track shall include an integral nut slot to accept a hardened steel square nut to facilitate attachment of each steel all-rod and splice brackets to the overhead structural support.
- B. Track Size: The track size shall be (selected from *Track and Carrier Selection Chart - refer to Page 1*):
 1. *Type 425 Multi-Directional Aluminum Track*: certified to be capable of supporting up to 525 lb. (238 kg) of total live load weight per panel.
 2. *Type 850 Multi-Directional Aluminum Track*: certified to be capable of supporting up to 850 lb. (386 kg) of total live load weight per panel.

2.11 CARRIER SYSTEMS

- A. Carrier Type: Each Individual Panel shall be top supported by two (2) carriers utilizing a 5/8" [16] diameter pendant bolt. Each carrier shall consist of dual horizontal, permanently lubricated, precision ground steel bearings with high strength polymer tires as required for smooth and quiet operation. Multi-Directional carriers shall be capable of negotiating 90° "X", "L" and "T" intersections as required for moving panels from storage location(s) to various installed positions.
- B. Carrier Size: The carrier size shall be:
 1. *Type 850 Multi-Directional Carrier*: certified to be capable of supporting up to 850 lb. (386 kg) of total live load weight per panel.

2.12 SUSPENSION SYSTEMS

- A. Mounting Systems: The track shall be supported by (select):

1. Optional Drop Rod Bracket Mount: consisting of 3/8" [10] thick steel brackets mounted to top of track and supported with adjustable rods of grade 2, 3/8" [10] diameter threaded steel all-rod provided with 3/8" [10] serrated steel nuts.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Proper and complete preparation of the operable wall system opening shall be by others in accordance with the architectural drawings, manufacturers shop drawings and ASTM E 557. Any deviation of the actual opening from these specifications shall be called to the attention of the architect prior to the installation of the operable wall.
- B. Deficiencies in the operable wall opening shall be corrected by others prior to installation of the operable wall.

3.02 INSTALLATION

- A. The operable wall system shall be installed by manufacturer's authorized distributor.
- B. The operable wall shall be installed in accordance with manufacturer's written instructions, shop drawings and ASTM E 557 installation guidelines.

3.03 ADJUSTING AND CLEANING

- A. The operable wall panels and track system shall be adjusted and cleaned in accordance with manufacturer's written instructions.

3.04 PROTECTION

- A. The operable wall panels shall be stored in the stacked (retracted) position prior to acceptance by the owner's representative.

3.05 DEMONSTRATION

- A. The operable wall manufacturer's authorized distributor shall demonstrate proper operation and explain proper and necessary maintenance requirements of the operable wall system to the owner's representative.

For additional information contact:

KWIK-WALL Company
4650 Industrial Ave.
Springfield, Illinois 62703
Phone: 217-522-5553 or 800-280-5945 (United States and Canada only)
Website: www.kwik-wall.com

END OF SECTION 10 22 26

SECTION 10 28 00 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes Toilet accessories:
 - 1. Toilet seat cover dispensers
 - 2. Soap Dispensers
 - 3. Grab Bars at toilet stalls
 - 4. Paper towel Dispensers
 - 5. Toilet tissue dispensers
 - 6. Sanitary Napkin Receptacle
 - 7. Mop and broom holders for janitor's closets
 - 8. Electric hand dryers
 - 9. Under lavatory Guards
- B. Related Sections include the following:
 - 1. Division 9 Section "Gypsum Board" for mounting substrate
 - 2. Division 9 Section "Fiber Reinforced Plastic (FRP) Panels" for mounting substrate

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Material and finish descriptions.
 - 4. Features that will be included for Project.
 - 5. Manufacturer's warranty.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated on Drawings.
- C. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Reference Standards:
1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
 2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
 3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
 4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
 5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
 6. 2019 California Energy Code, Part 6, Title 24 CCR
 7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
 8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
 9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
 10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

1.5 COORDINATION

- B. 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.
- C. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace toilet and bath accessories that fails in materials or workmanship within specified warranty period.
1. Warranty Period: 1 year.
- B. Installer's Warranty: 1 year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Toilet and Bath Accessories: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified in a brushed stainless finish.
 - 1. Bobrick Washroom Equipment, Inc. (BASIS OF DESIGN)
 - 2. Or equal. (For substitution requirements refer to Division 01 Section)
- B. Under lavatory Guards: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1. Handy-Shield by Plumberex Specialty Products, Inc. (Basis of Design)
 - 2. TCI Products.
 - 3. Truebro, Inc.
 - 4. Or equal. Refer to Section 01 60 00 for substitution requirements

2.2 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated. (brushed stainless steel finish)
- B. Steel Sheet: ASTM A 1008, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.
- C. Galvanized Steel Sheet: ASTM A 653, with G60 hot-dip zinc coating.
- D. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and- theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.3 TOILET ACCESSORIES

- A. As indicated on Drawings.
 - 1. Surface mount toilet seat cover dispenser-Model # B-221
 - 2. Surface mount soap dispenser – Model # B-2111
 - 3. Surface mount toilet tissue dispenser (multi-roll)- Model # 2888
 - 4. Grab bars:
 - a. Side: Model # 5806 X 42 MIN.
 - b. Rear: Model # 5806 X 36 MIN.
 - c. Drinking fountain model #819298
 - 6. Framed mirror - Model # B-165 1830
 - 7. Surface mount Sanitary Napkin Receptacle: Model # B-270
 - 8. Electric Hand Dryer – Bobrick “Terra dry” Model # 7128

2.4 UNDER LAVATORY GUARDS

- A. Under lavatory Guard:
 - 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping and allow service access without removing coverings.
 - 2. Material and Finish: Antimicrobial, molded-plastic, white.

2.5 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.
 - 1. Provide minimum of six keys to Owner's representative.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install accessories according to 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 withstand a downward load of at least 250 lbf, when tested

according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations

END OF SECTION 10 28 00

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SECTION 10 44 00 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers.
 - 2. Fire-protection cabinets for the following:
 - a. Portable fire extinguishers.
 - 3. Mounting brackets for fire extinguishers.
- B. Related Sections include the following:
 - 1. Division 10 Section "Signage" for directional signage to out-of-sight fire extinguishers and cabinets.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- B. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.
- C. Samples for Verification: For each type of exposed factory-applied color finish required for fire-protection cabinets, prepared on Samples of size indicated below.
 - 1. Size: 6 by 6 inches square.
- D. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. 2022 California Administrative Code (CAC) Part 1, Title 24 CCR
2. 2019 California Building Code, VOL. 1&2 (CBC), Part 2, Title 24 CCR
3. 2019 California Electrical Code (CEC), Part 3, Title 24 CCR
4. 2019 California Mechanical Code (CMC) Part 4, Title 24 CCR
5. 2019 California Plumbing Code (CPC), Part 5, Title 24 CCR
6. 2019 California Energy Code, Part 6, Title 24 CCR
7. 2019 California Fire Code (CFC) Part 9, Title 24 CCR
8. 2019 California Green Building Code, (CALGreen), Part 11, Title 24 CCR
9. 2019 California Referenced Standards Code, Part 12, Title 24 CCR
10. Title 19 CCR, Public Safety, State Fire Marshall Regulations

Applicable Standards: For a list of applicable standards, including California Amendments to the NFPA Standards, refer to CDC Chapter 35 and CFC Chapter 80.

- ##### B. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.
- ##### C. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10-1998 Edition, "Portable Fire Extinguishers."
- ##### D. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
1. Provide fire extinguishers approved, listed, and labeled by FMG.
- ##### E. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

- ##### A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

1.6 WARRANTY

- ##### A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.

- b. Faulty operation of valves or release levers.
2. Warranty Period: 6 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fire Extinguishers and Cabinets: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 1. JL Industries, Inc. (Basis of Design)
 2. Larsen's Manufacturing Company
 3. Potter Roemer; Div. of Smith Industries, Inc.
 4. Ansul.
 5. Or equal (Reference substitution requirements in Division 01 Section)

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B.
- B. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick minimum.

2.3 PORTABLE FIRE EXTINGUISHERS

- A. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 1. Valves: Manufacturer's standard.
 2. Handles and Levers: Manufacturer's standard.
 3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Dry Chemical Type: Cast steel tank, with pressure gage.
 1. Class 2A-10B:C.
 2. Nominal Capacity: Provide 10 lbs. capacity fire extinguisher.
 3. Finish: Baked enamel, red color.

2.4 FIRE-PROTECTION CABINET

- A. J.L Industries ("Basis of Design") or Equal.

1. Cabinet Type: "Ambassador Series" with pull. Suitable for fire extinguisher specified.
2. Construction:
 - a. Non-rated (Model# 1015W10).
3. Mounting: Provide Recessed
4. Cabinet Trim and Door Material: Steel sheet
5. Door Style:
 - a. Vertical Duo Door with tempered safety glass.
6. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - a. Provide manufacturer's standard.
 - b. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
7. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
8. Door Lock: Cylinder lock, keyed alike to other cabinets.
9. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
 - a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door glass (vertical)
 - 2) Application Process: Silk-screened/ decal.
 - 3) Orientation: Vertical.
10. Finishes:
 - a. Steel: Factory baked enamel or powder coat.

2.5 MOUNTING BRACKETS

- A. Manufacturers:
 1. JL Industries, Inc.
 2. Larsen's Manufacturing Company.
 3. Potter Roemer; Div. of Smith Industries, Inc.
 4. Or equal (Reference substitution requirements in Division 01 Section)
- B. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 1. Color: Red.
- C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter.
 - a. Orientation: Vertical.

2.6 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. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch-thick, cold-rolled steel sheet lined with minimum 5/8-inch-thick, fire-barrier material.
 - a. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 FINISHES, GENERAL

- 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. Finish fire-protection cabinets after assembly.
- D. 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 the 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.

2.8 STEEL FINISHES

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.
- B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
 - 1. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where cabinets will be installed.
- B. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed and semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated on Drawings.
- B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed 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.

- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties 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 manufacturer.
- 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 10 44 00

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SECTION 12 93 13 – BICYCLE RACKS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This section includes specifications for Horizontal Bicycle Racks.

1.2 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed installation of bicycle racks similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing bicycle racks similar to those required for this project and with a record of successful in-service performance.
- C. **Source Limitations:** Obtain each color, finish, shape and type of bicycle rack from a single source with resources
- D. Provide components of consistent quality in appearance and physical properties.
- E. **Product Options:** Drawings indicate size, shape and dimensional requirements of bicycle racks and are based on the specific system indicated.

1.3 SUBMITTALS

- A. **Product Data:** Include physical characteristics such as shape, dimensions, bicycle parking capacity and finish for each bicycle rack.
- B. **Shop Drawings:** Show installation details for each size of bicycle rack listed.
- C. **Samples for Verification:** Submit finish samples for review and verification.
- D. **Maintenance Data:** For each bicycle rack.
 - 1. Include recommended methods for repairing damage to the finish.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Upon delivery, before signing for shipment, inspect for any damages and do not accept damaged material
- B. Store bicycle racks in original undamaged packages and containers until ready for installation
- C. Handle bicycle racks with sufficient care to prevent any scratches or damage to the finish.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Provide bicycle racks manufactured by DERO BIKE RACK CO., 42 Northern Stacks Drive, Suite 100, Minneapolis, MN 55421, 1-888-337-6729. Fax: 612-331-2731
Website: www.dero.com
- B. Or equal see Section 01 60 00 for Substitution Requirements

2.2 ROLLING BIKE RACK

- A. Bikes parked per unit:
 - 1. RR2H: 5 bikes

2.3 Type of mounting:

- A. Surface mount Rolling Racks have two 5.5" x 5.25" x .25" feet.

2.4 MATERIALS

- A. 2.375" OD Schedule 40 Pipe per ASTM A53

2.3 FINISHES

- A. A hot-dipped galvanized finish performed after fabrication.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Flange mount has two 5.5" x 5.25" x .25" feet plates - 8 anchors.

B. It is the responsibility of the installer to ensure that all base materials into which the rack will be installed can support the rack and will not be damaged by any required installation procedures.

A. Setbacks:

1. Wall Setback: A minimum of 27" should be left between the wall and the rack. 36" is the recommended setback.
2. Street Setback: For racks running parallel to the street or walkway a 96" setback is recommended. For racks installed perpendicular to the street or walkway a 24" setback is the minimum setback distance between the street and the rack. 36" is recommended.
3. The foot-mounted Rolling Rack has a 5.5" x 5.25" x .25" plate which is installed onto a concrete base with 4 masonry anchors. The foot-mounted Rolling Rack is generally less expensive to install and easier to remove than the in-ground mount model, while maintaining the same degree of security. 3/8" anchors are the standard anchor shipped with this rack

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SECTION 14 24 00 - HYDRAULIC PASSENGER ELEVATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydraulic passenger elevators (Type Holeless) as shown and specified.

Elevator work includes:

1. Standard pre-engineered hydraulic passenger elevators.
2. Elevator car enclosures, hoistway entrances and signal equipment.
3. Operation and control systems.
4. Accessibility provisions for physically disabled persons.
5. Equipment, machines, controls, systems and devices as required for safely operating the specified elevators at their rated speed and capacity.
6. Materials and accessories as required to complete the elevator installation.

B. Related Sections:

1. Division 1 General Requirements: Meet or exceed all referenced sustainability requirements.
2. Division 3 Concrete: Installing inserts, sleeves and anchors in concrete.
3. Division 4 Masonry: Installing inserts, sleeves and anchors in masonry.
4. Division 5 Metals:
 - a. Providing hoist beams, pit ladders, steel framing, auxiliary support steel and divider beams for supporting guide-rail brackets.
 - b. Providing steel angle sill supports and grouting hoistway entrance sills and frames.
5. Division 9 Finishes: Providing elevator car finish flooring and field painting unfinished and shop primed ferrous materials.
6. Division 16 Sections:
 - a. Providing electrical service to elevators, including fused disconnect switches.
 - b. Emergency power supply, transfer switch and auxiliary contacts.
 - c. Heat and smoke sensing devices.
 - d. Convenience outlets and illumination in control room, hoistway and pit.
7. Division 22 Plumbing
 - a. Sump pit and oil interceptor.
8. Division 23 Heating, Ventilation and Air Conditioning
 - a. Heating and ventilating hoistways and/or control room.

- C. Work Not Included: General contractor shall provide the following in accordance with the requirements of the Model Building Code and ANSI A17.1 Code. For specific rules, refer to ANSI A17.1, Part 3 for hydraulic elevators. State or local requirements must be used if more stringent. The cost of this work is not included in the Thyssenkrupp Elevator's proposal, since it is a part of the building construction.
1. Elevator hoist beam to be provided at top of elevator shaft. Beam must be able to accommodate proper loads and clearances for elevator installation and operation.
 2. Supply in ample time for installation by other trades, inserts, anchors, bearing plates, brackets, supports and bracing including all setting templates and diagrams for placement.
 3. Hatch walls require a minimum two hours of fire rating. Hoistway should be clear and plumb with variations not to exceed 1/2" at any point.
 4. Elevator hoistways shall have barricades, as required.
 5. Install bevel guards at 75° on all recesses, projections or setbacks over 2" (4" for A17.1 2000 areas) except for loading or unloading.
 6. Provide rail bracket supports at pit, each floor and roof. For guide rail bracket supports, provide divider beams between hoistway at each floor and roof.
 7. Pit floor shall be level and free of debris. Reinforce dry pit to sustain normal vertical forces from rails and buffers.
 8. Where pit access is by means of the lowest hoistway entrance, a vertical ladder of non-combustible material extending 42" minimum, (48" minimum for A17.1-2000 areas) shall be provided at the same height, above sill of access door or handgrips.
 9. Machine room to be enclosed and protected.
 10. Machine Room temperature must be maintained between 55° and 90° F.
 11. If machine room is remote from the elevator hoistway, clear access must be available above the ceiling or metal/concrete raceways in floor for oil line and wiring duct from machine room.
 12. Access to the machinery space and machine room must be in accordance with the governing authority or code.
 13. Provide an 8" x 16" cutout through machine room wall, for oil line and wiring duct, coordinated with elevator contractor at the building site.
 14. All wire and conduit should run remote from the hoistways.

15. When heat, smoke or combustion sensing devices are required, connect to elevator control cabinet terminals. Contacts on the sensors should be sided for 12-volt D.C.
16. Install and furnish finished flooring in elevator cab.
17. Finished floors and entrance walls are not to be constructed until after sills and door frames are in place. Consult elevator contractor for rough opening size. The general contractor shall supply the drywall framing so that the wall fire resistance rating is maintained when drywall construction is used.
18. Where sheet rock or drywall construction is used for front walls, it shall be of sufficient strength to maintain the doors in true lateral alignment. Drywall contractor to coordinate with elevator contractor.
19. Before erection of rough walls and doors; erect hoistway sills, headers, and frames. After rough walls are finished, erect fascia's and toe guards. Set sill level and slightly above finished floor at landings.
20. To maintain legal fire rating (masonry construction), door frames are to be anchored to walls and properly grouted in place.
21. The elevator wall shall interface with the hoistway entrance assembly and be in strict compliance with the elevator contractor's requirements.
22. General Contractor shall fill and grout around entrances, as required.
23. Elevator sill supports shall be provided at each opening.
24. All walls and sill support must be plumb where openings occur.
25. For applications with jack hole, free and clear access to the elevator pit area for the jack hole-drilling rig is required.
26. Where jack hole is required, remove all spoils from jack hole drilling.
27. When not provided by Elevator Contractor, jack hole shall accommodate the jack unit. If required, the jack hole is to be provided in strict accordance with the elevator contractor's shop drawings.
28. Locate a light fixture (200 lx / 19 fc) and convenience outlet in pit with switch located adjacent to the access door.
29. A light switch and fused disconnect switch for each elevator should be located inside the machine room adjacent to the door, where practical, per the National Electrical Code (NFPA No. 70).
30. For signal systems and power operated door: provide ground and branch wiring circuits, including main line switch.
31. For car light and fan: provide a feeder and branch wiring circuits, including main line switch.

32. Wall thickness may increase when fixtures are mounted in drywall. These requirements must be coordinated between the general contractor and the elevator contractor.
33. Provide supports, patching and recesses to accommodate hall button boxes, signal fixtures, etc..
34. Locate telephone and convenience outlet on control panel.

1.02 SUBMITTALS

- A. Product data: When requested, the elevator contractor shall provide standard cab, entrance and signal fixture data to describe product for approval.
- B. Shop drawings:
 1. Show equipment arrangement in the corridor, pit, and hoistway and/or optional control room. Provide plans, elevations, sections and details of assembly, erection, anchorage, and equipment location.
 2. Indicate elevator system capacities, sizes, performances, safety features, finishes and other pertinent information.
 3. Show floors served, travel distances, maximum loads imposed on the building structure at points of support and all similar considerations of the elevator work.
 4. Indicate electrical power requirements and branch circuit protection device recommendations.
- C. Powder Coat paint selection: Submit manufacturer's standard selection charts for exposed finishes and materials.
- D. Plastic laminate selection: Submit manufacturer's standard selection charts for exposed finishes and materials.
- E. Metal Finishes: Upon request, standard metal samples provided.
- F. Operation and maintenance data. Include the following:
 1. Owner's manuals and wiring diagrams.
 2. Parts list, with recommended parts inventory.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An approved manufacturer with minimum 15 years of experience in manufacturing, installing, and servicing elevators of the type required for the project.
1. The manufacturer of machines, controllers, signal fixtures, door operators cabs, entrances, and all other major parts of elevator operating equipment.
 - a. The major parts of the elevator equipment shall be manufactured by the installing company, and not be an assembled system.
 2. The manufacturer shall have a documented, on-going quality assurance program.
 3. ISO-9001:2000 Manufacturer Certified
 4. ISO-14001:2004 Environmental Management System Certified
 5. LEED Gold certified elevator manufacturing facility.
- B. Installer Qualifications: The manufacturer or an authorized agent of the manufacturer with not less than 15 years of satisfactory experience installing elevators equal in character and performance to the project elevators.
- C. Regulatory Requirements:
1. ASME A17.1 Safety Code for Elevators and Escalators, latest edition or as required by the local building code.
 2. Building Code: National.
 3. NFPA 70 National Electrical Code.
 4. NFPA 80 Fire Doors and Windows.
 5. Americans with Disabilities Act - Accessibility Guidelines (ADAAG)
 6. Section 407 in ICC A117.1, when required by local authorities
 7. CAN/CSA C22.1 Canadian Electrical Code
 8. CAN/CSA B44 Safety Code for Elevators and Escalators.
 9. California Department of Public Health Standard Method V1.1–2010, CA Section 01350
- D. Fire-rated entrance assemblies: Opening protective assemblies including frames, hardware, and operation shall comply with ASTM E2074, CAN4-S104 (ULC-S104), UL10(b), and NFPA Standard 80. Provide entrance assembly units bearing Class B or 1 1/2 hour label by a Nationally Recognized Testing Laboratory (2 hour label in Canada).
- E. Inspection and testing:
1. Elevator Installer shall obtain and pay for all required inspections, tests, permits and fees for elevator installation.

2. Arrange for inspections and make required tests.
 3. Deliver to the Owner upon completion and acceptance of elevator work.
- F. Sustainable Product Qualifications:
1. Environmental Product Declaration:
 - a. GOOD: If Product Category Rules (PCR) are not available, produce a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that has at least a cradle to gate scope.
 - b. BEST: If Product Category Rules (PCR) are available, produce and publish an Environmental Product Declaration (EPD) based on a critically reviewed life-cycle assessment conforming to ISO 14044, with external verification recognized by the EPD program operator.
 2. Material Transparency:
 - a. GOOD: Provide Health Product Declaration at any level
 - b. BETTER: Provide Health Product Declaration (HPD v2 or later). Complete, published declaration with full disclosure of known hazards, prepared using the Health Product Declaration Collaborative's "HPD builder" on-line tool.
 - c. BEST: Cradle to Cradle Material Health Certificate v3, Bronze level or higher.
 3. Living Building Challenge Projects: Provide Declare label for products specified.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Manufacturing shall deliver elevator materials, components and equipment and the contractor is responsible to provide secure and safe storage on job site.

1.05 PROJECT CONDITIONS

- A. Temporary Use: Elevators shall not be used for temporary service or for any other purpose during the construction period before Substantial Completion and acceptance by the purchaser unless agreed upon by Elevator Contractor and General Contractor with signed temporary agreement.
- B. Provide the hole for the jack unit (if required by the type of jack provided), based on excavation through normal soil or clay which can be removed by manual digging or by standard truck-mounted regular drilling unit. Provide a casing if required to retain the walls of the hole. General contractor shall remove excavation spoils deposited in the elevator pit.
 1. If a physical obstruction or hindrance is encountered below the ground surface, including boulders, rock, gravel, wood, metal, pilings, sand, water, quick sand, caves, public utilities

or any other foreign material, obtain written authorization to proceed with excavating using special excavation equipment.

2. Maintain a daily log of time and material costs involved.
3. Elevator contractor will be compensated on a time and material basis for additional costs incurred after encountering the physical obstruction or hindrance, including the cost of the special excavation equipment.

1.06 WARRANTY

- A. Warranty: Submit elevator manufacturer's standard written warranty agreeing to repair, restore or replace defects in elevator work materials and workmanship not due to ordinary wear and tear or improper use or care for 12 months after final acceptance.

1.07 MAINTENANCE

- A. Furnish maintenance and call back service for a period of 3 months for each elevator after completion of installation or acceptance thereof by beneficial use, whichever is earlier, during normal working hours excluding callbacks.
 1. Service shall consist of periodic examination of the equipment, adjustment, lubrication, cleaning, supplies and parts to keep the elevators in proper operation. Maintenance work, including emergency call back repair service, shall be performed by trained employees of the elevator contractor during regular working hours.
 2. Submit parts catalog and show evidence of local parts inventory with complete list of recommended spare parts. Parts shall be produced by manufacturer of original equipment.
 3. Manufacturer shall have a service office and full time service personnel within a 100 mile radius of the project site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer: Design based around Thyssenkrupp Elevator's Endura hydraulic elevator.

2.02 MATERIALS, GENERAL

- A. All Elevator Cab materials including frame, buttons, lighting, wall and ceiling assembly, laminates and carpet shall have an EPD and an HPD, and shall meet the California

Department of Public Health Standard Method V1.1–2010, CA Section 01350 as mentioned in 1.03.9 of this specification.

B. Colors, patterns, and finishes: As specified here. Any other finishes to be selected by the Architect from manufacturer's full range of standard colors, patterns, and finishes.

1. Hoistway entrances

- a. Sills - extruded aluminum
- b. Door - hollow metal construction with internal channel reinforcement
- c. Entrance material -14 gauge stainless steel with brushed finish

2. Steel cab

- a. Cab wall finish - back wall central panel - Flemish linen textured stainless steel
- b. Back and side wall panels - brushed stainless steel grade 441
- c. Cab front and door finish - brushed stainless steel grade 441
- d. Downlight Ceiling - suspended ceiling shall consist of brushed stainless steel grade 441 panels with 6 recessed rectangular Led light fixture

3. Floor Finish - Match Lobby Floor Finish, per Finish Schedule and Finish Key Schedule on the Drawings.

4. Threshold-extruded aluminum

5. Protective pad hooks and quilted fire retardant protective pads hung from ceiling.

C. Steel:

1. Shapes and bars: Carbon.
2. Sheet: Cold-rolled steel sheet, commercial quality, Class 1, matte finish.
3. Finish: Factory-applied baked enamel for structural parts, powder coat for architectural parts. Color selection must be based on elevator manufacture's standard selections.

D. Plastic laminate: Decorative high-pressure type, complying with NEMA LD3, Type GP-50 General Purpose Grade, nominal 0.050" thickness. Laminate selection must be based on elevator manufacture's standard selections.

E. Flooring by others.

2.03 HOISTWAY EQUIPMENT

- A. Platform: Fabricated frame of formed or structural steel shapes, gusseted and rigidly welded with a wood sub-floor. Underside of the platform shall be fireproofed. The car platform shall be designed and fabricated to support one-piece loads weighing up to 25% of the rated capacity.
- B. Sling: Steel stiles bolted or welded to a steel crosshead and bolstered with bracing members to remove strain from the car enclosure.
- C. Guide Rails: Steel, omega shaped, fastened to the building structure with steel brackets.
- D. Guides: Slide guides shall be mounted on top and bottom of the car.
- E. Buffers: Provide substantial buffers in the elevator pit. Mount buffers on continuous channels fastened to the elevator guide rail or securely anchored to the pit floor. Provide extensions if required by project conditions.
- F. Jack: A jack unit shall be of sufficient size to lift the gross load the height specified. Factory test jack to ensure adequate strength and freedom from leakage. Brittle material, such as gray cast iron, is prohibited in the jack construction. Provide the following jack type: Twin post hole less. Two jacks piped together, mounted one on each side of the car with a polished steel hydraulic plunger housed in a sealed steel casing having sufficient clearance space to allow for alignment during installation. Each plunger shall have a high-pressure sealing system which will not allow for seal movement or displacement during the course of operation. Each Jack Assembly shall have a check valve built into the assembly to allow for automatically re-syncing the two plunger sections by moving the jack to its fully contracted position. The jack shall be designed to be mounted on the pit floor or in a recess in the pit floor. Each jack section shall have a bleeder valve to discharge any air trapped in the section..
- G. Automatic Self-Leveling: Provide each elevator car with a self-leveling feature to automatically bring the car to the floor landings and correct for over travel or under travel. Self-leveling shall, within its zone, be automatic and independent of the operating device. The car shall be maintained approximately level with the landing irrespective of its load.

- H. Wiring, Piping, and Oil: Provide all necessary hoistway wiring in accordance with the National Electrical Code. All necessary code compliant pipe and fittings shall be provided to connect the power unit to the jack unit.

2.04 POWER UNIT

- A. Power Unit (Oil Pumping and Control Mechanism): A self-contained unit consisting of the following items:
 - 1. An oil reservoir with tank cover.
 - 2. An oil hydraulic pump.
 - 3. An electric motor.
 - 4. An oil control valve with the following components built into single housing; high pressure relief valve, check valve, automatic unloading up start valve, lowering and leveling valve, and electro-magnetic controlling solenoids.
- B. Pump: Positive displacement type pump specifically manufactured for oil-hydraulic elevator service. Pump shall be designed for steady discharge with minimum pulsation to give smooth and quiet operation. Output of pump shall not vary more than 10 percent between no load and full load on the elevator car.
- C. Motor: Standard manufacture motor specifically designed for oil-hydraulic elevator service. Duty rating shall be selected for specified speed and load.
- D. Oil Control Unit: The following components shall be built into a single housing. Welded manifolds with separate valves to accomplish each function are not acceptable. Adjustments shall be accessible and be made without removing the assembly from the oil line.
 - 1. Relief valve shall be adjustable and be capable of bypassing the total oil flow without increasing back pressure more than 10 percent above that required to barely open the valve.
 - 2. Up start and stop valve shall be adjustable and designed to bypass oil flow during start and stop of motor pump assembly. Valve shall close slowly, gradually diverting oil to or from the jack unit, ensuring smooth up starts and up stops.
 - 3. Check valve shall be designed to close quietly without permitting any perceptible reverse flow.
 - 4. Lowering valve and leveling valve shall be adjustable for down start speed, lowering speed, leveling speed and stopping speed to ensure smooth "down" starts and stops.

The leveling valve shall be designed to level the car to the floor in the direction the car is traveling after slowdown is initiated.

5. Provided with constant speed regulation in both up and down direction. Feature to compensate for load changes, oil temperature, and viscosity changes.
6. Solid State Starting: Provide an electronic starter featuring adjustable starting currents.
7. Oil Type: Provide a zinc free, inherently biodegradable lubricant formulated with premium base stocks to provide outstanding protection for demanding hydraulic systems, especially those operating in environmentally sensitive areas.

2.05 HOISTWAY ENTRANCES

- A. Doors and Frames: Provide complete hollow metal type hoistway entrances at each hoistway opening bolted\knock down construction.
 1. Manufacturer's standard entrance design consisting of hangers, doors, hanger supports, hanger covers, fascia plates (where required), sight guards, and necessary hardware.
 2. Main landing door & frame finish: ASTM A1008 steel panels, factory applied powder coat finish.
 3. Typical door & frame finish: ASTM A 366 steel panels, factory applied powder coat finish.
- B. Interlocks: Equip each hoistway entrance with an approved type interlock tested as required by code. Provide door restriction devices as required by code.
- C. Door Hanger and Tracks: Provide sheave type two point suspension hangers and tracks for each hoistway horizontal sliding door.
 1. Sheaves: Polyurethane tires with ball bearings properly sealed to retain grease.
 2. Hangers: Provide an adjustable device beneath the track to limit the up-thrust of the doors during operation.
 3. Tracks: Drawn steel shapes, smooth surface and shaped to conform to the hanger sheaves.
- D. Hoistway Sills: Extruded metal, with groove(s) in top surface. Provide mill finish on aluminum.

2.06 PASSENGER ELEVATOR CAR ENCLOSURE

A. Car Enclosure:

1. Walls: Cab Type: Steel, with interior finish panels per Paragraph 2.02 B.2 of this Specification.
 2. Reveals and frieze: Not applicable
 3. Canopy: Cold-rolled steel with hinged exit.
 4. Ceiling: Suspended type, LED lighting with translucent diffuser mounted in a metal frame. Framework shall be finished with a factory applied powder coat finish.
 5. Cab Fronts, Return, Transom, Soffit and Strike: Provide panels faced with No. 4 brushed stainless steel
 6. Doors: Horizontal sliding car doors reinforced with steel for panel rigidity. Hang doors on sheave type hangers with polyurethane tires that roll on a polished steel track and are guided at the bottom by non-metallic sliding guides.
 - a. Door Finish: Stainless steel panels: No. 4 brushed finish.
 - b. Cab Sills: Extruded aluminum, mill finish.
 7. Handrail: Provide 1.5" diameter cylindrical metal on side and rear walls on front opening cars and side walls only on front and rear opening cars. Handrails shall have a stainless steel, No. 4 brushed finish.
 8. Ventilation: Manufacturer's standard exhaust fan, mounted on the car top.
 9. Protection pads and buttons: Not required
- B. Car Top Inspection: Provide a car top inspection station with an "Auto-Inspection" switch, an "emergency stop" switch, and constant pressure "up and down" direction and safety buttons to make the normal operating devices inoperative. The station shall give the inspector complete control of the elevator. The car top inspection station shall be mounted in the door operator assembly.

2.07 DOOR OPERATION

- A. Door Operation: Provide a direct or alternating current motor driven heavy duty operator designed to operate the car and hoistway doors simultaneously. The door control system shall be digital closed loop and the closed loop circuit shall give constant feedback on the position and velocity of the elevator door. The motor torque shall be constantly adjusted to maintain the correct door speed based on its position and load. All adjustments and setup shall be through the computer based service tool. Door movements shall follow a field programmable speed pattern with smooth acceleration and deceleration at the ends of travel. The mechanical door operating mechanism shall be arranged for manual operation in event of power failure. Doors shall automatically

open when the car arrives at the landing and automatically close after an adjustable time interval or when the car is dispatched to another landing. AC controlled units with oil checks, or other deviations are not acceptable.

1. No Un-Necessary Door Operation: The car door shall open only if the car is stopping for a car or hall call, answering a car or hall call at the present position or selected as a dispatch car.
2. Door Open Time Saver: If a car is stopping in response to a car call assignment only (no coincident hall call), the current door hold open time is changed to a shorter field programmable time when the electronic door protection device is activated.
3. Double Door Operation: When a car stops at a landing with concurrent up and down hall calls, no car calls, and no other hall call assignments, the car door opens to answer the hall call in the direction of the car's current travel. If an onward car call is not registered before the door closes to within 6 inches of fully closed, the travel shall reverse and the door shall reopen to answer the other call.
4. Nudging Operation: The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If door closing is prevented for a field programmable time, a buzzer shall sound. When the obstruction is removed, the door shall begin to close at reduced speed. If the infra-red door protection system detects a person or object while closing on nudging, the doors shall stop and resume closing only after the obstruction has been removed.
5. Door Reversal: If the doors are closing and the infra-red beam(s) is interrupted, the doors shall reverse and reopen. After the obstruction is cleared, the doors shall begin to close.
6. Door Open Watchdog: If the doors are opening, but do not fully open after a field adjustable time, the doors shall recycle closed then attempt to open six times to try and correct the fault.
7. Door Close Watchdog: If the doors are closing, but do not fully close after a field adjustable time, the doors shall recycle open then attempt to close six times to try and correct the fault.
8. Door Close Assist: When the doors have failed to fully close and are in the recycle mode, the door drive motor shall have increased torque applied to possibly overcome mechanical resistance or differential air pressure and allow the door to close.

- B. Door Protection Device: Provide a door protection system using microprocessor controlled infra-red light beams. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen.

2.08 CAR OPERATING STATION

- A. Car Operating Station, General: The main car control in each car shall contain the devices required for specific operation mounted in an integral swing return panel requiring no applied faceplate. Wrap return shall have a No. 4 brushed stainless steel finish. The main car operating panel shall be mounted in the return and comply with handicap requirements. Pushbuttons that illuminate using long lasting LED's shall be included for each floor served, and emergency buttons and switches shall be provided per code. Switches for car light and accessories shall be provided.
- B. Emergency Communications System: Integral phone system provided.
- C. Auxiliary Operating Panel: Not Required
- D. Column Mounted Car Riding Lantern: A car riding lantern shall be installed in the elevator cab and located in the entrance. The lantern, when illuminated, will indicate the intended direction of travel. The lantern will illuminate and a signal will sound when the car arrives at a floor where it will stop. The lantern shall remain illuminated until the door(s) begin to close.
- E. Special Equipment: Not Applicable

2.09 CONTROL SYSTEMS

- A. Controller: The elevator control system shall be microprocessor based and software oriented. Control of the elevator shall be automatic in operation by means of push buttons in the car numbered to correspond to floors served, for registering car stops, and by "up-down" push buttons at each intermediate landing and "call" push buttons at terminal landings.

- B. Automatic Light and Fan shut down: The control system shall evaluate the system activity and automatically turn off the cab lighting and ventilation fan during periods of inactivity. The settings shall be field programmable.
- C. Emergency Power Operation: (10-DOA) Upon loss of the normal power supply, building-supplied standby power is available on the same wires as the normal power supply. Once the loss of normal power is detected and standby power is available, the elevator is lowered to a pre-designated landing and the doors are opened. After passengers have exited the elevator, the doors are closed and the car is shut down. When normal power is restored, the elevator automatically resumes operation.
- D. Special Operation: Not Applicable

2.10 HALL STATIONS

- A. Hall Stations, General: Buttons shall illuminate to indicate call has been registered at that floor for the indicated direction.
 - 1. Provide one pushbutton riser with faceplates having a No. 4 brushed stainless-steel finish.
 - a. Phase 1 firefighter's service key switch, with instructions, shall be incorporated into the hall station at the designated level.
- B. Floor Identification Pads: Provide door jamb pads at each floor. Jamb pads shall comply with Americans with Disabilities Act (ADA) requirements.
- C. Hall Position Indicator: Not Applicable
- D. Hall lanterns: Not Applicable
- E. Special Equipment: Not Applicable

2.11 MISCELLANEOUS ELEVATOR COMPONENTS

- A. Oil Hydraulic Silencer: Install multiple oil hydraulic silencers (muffler device) at the power unit location. The silencers shall contain pulsation absorbing material inserted in a blowout proof housing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before starting elevator installation, inspect hoistway, hoistway openings, pits and/or control room, as constructed, verify all critical dimensions, and examine supporting structures and all other conditions under which elevator work is to be installed. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 INSTALLATION

- A. Install elevator systems components and coordinate installation of hoistway wall construction.
 - 1. Work shall be performed by competent elevator installation personnel in accordance with ASME A17.1, manufacturer's installation instructions and approved shop drawings.
 - 2. Comply with the National Electrical Code for electrical work required during installation.
- B. Jack unit excavation (if required by the type of jack provided): Drill or otherwise excavate below elevator pit construction as required to install the jack unit.
 - 1. Install casing for jack unit.
 - 2. Provide HDPE jack protection system for all in ground jacks.
 - 3. Set casing for jack unit assembly plumb, and partially fill with water set-tled sand, eliminating voids. Back fill depth shall be sufficient to hold the bottom of the jack in place over time.
- C. Perform work with competent, skilled workmen under the direct control and supervision of the elevator manufacturer's experienced foreman.
- D. Supply in ample time for installation by other trades, inserts, anchors, bearing plates, brackets, supports, and bracing including all setting templates and diagrams for placement.
- E. Welded construction: Provide welded connections for installation of elevator work where bolted connections are not required for subsequent removal or for normal operation,

adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualification of welding operators.

- F. Coordination: Coordinate elevator work with the work of other trades, for proper time and sequence to avoid construction delays. Use benchmarks, lines, and levels designated by the Contractor, to ensure dimensional coordination of the work.
- G. Install machinery, guides, controls, car and all equipment and accessories to provide a quiet, smoothly operating installation, free from side sway, oscillation or vibration.
- H. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum safe, workable dimensions at each landing.
- I. Erect hoistway sills, headers, and frames before erection of rough walls and doors; erect fascia and toe guards after rough walls finished. Set sill units accurately aligned and slightly above finish floor at landings.
- J. Lubricate operating parts of system, where recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

- A. Acceptance testing: Upon completion of the elevator installation and before permitting use of elevator, perform acceptance tests as required and recommended by Code and governing regulations or agencies. Perform other tests, if any, as required by governing regulations or agencies.
- B. Advise Owner, Contractor, Architect, and governing authorities in advance of dates and times tests are to be performed on the elevator.

3.04 ADJUSTING

- A. Make necessary adjustments of operating devices and equipment to ensure elevator operates smoothly and accurately.

3.05 CLEANING

- A. Before final acceptance, remove protection from finished surfaces and clean and polish surfaces in accordance with manufacturer's recommendations for type of material and finish provided. Stainless steel shall be cleaned with soap and water and dried with a non-abrasive surface; it shall not be cleaned with bleach-based cleansers.
- B. At completion of elevator work, remove tools, equipment, and surplus materials from site. Clean equipment rooms and hoistway. Remove trash and debris.
 - 1. Use environmentally preferable and low VOC emitting cleaners for each application type. Cleaners that contain solvents, pine and/or citrus oils are not permitted.

3.06 PROTECTION

- A. At time of Substantial Completion of elevator work, or portion thereof, provide suitable protective coverings, barriers, devices, signs, or other such methods or procedures to protect elevator work from damage or deterioration. Maintain protective measures throughout remainder of construction period.

3.07 DEMONSTRATION

- A. Instruct Owner's personnel in proper use, operations, and daily maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at time of failure in operation and other building emergencies. Train Owner's personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions.
- B. Make a final check of each elevator operation, with Owner's personnel present, immediately before date of substantial completion. Determine that control systems and operating devices are functioning properly.

3.08 ELEVATOR SCHEDULE

- A. Elevator Qty. 1
 - 1. Elevator Model: Endura 35 Above-Ground **(2-Stage)**
 - 2. Elevator Type: Hydraulic Passenger

3. Rated Capacity: 3500 lbs.
4. Rated Speed: 83 ft./min. up; 100 ft./min. down
5. Operation System: TAC32H
6. Travel: 15'-0"
7. Landings: 2 total
8. Openings:
 - a. Front: **2 (One at each Level)**
 - b. Rear: 0
9. Clear Car Inside: 6' - 8" wide x 5' - 5" deep
10. Cab Height: 8'-0" standard
11. Hoistway Entrance Size: 3' - 6" wide x 7'-0" high
12. Door Type: Single Speed
13. Power Characteristics: 208 volts, 3 Phase, 60 Hz.
14. Seismic Requirements: Zone 1
15. Hoistway Dimensions: 8' - 4" wide x 6' - 11" deep
16. Pit Depth: 4' - 0"
17. Button & Fixture Style: Traditional Signal Fixtures
18. Special Operations: None

END OF SECTION 14 24 00

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SECTION 21 00 00 - FIRE SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 GENERAL MECHANICAL PROVISIONS:

- A. The General Mechanical Provisions, Section 23 00 00, shall form a part of this Section with the same force and effect as though repeated here.

1.2 SCOPE:

- A. General: Provide all labor, materials and services necessary for complete, lawful and operating systems as shown or noted on the drawings or as specified here. The entire building shall be fire sprinklered.
- B. Design/Calculations: The sprinkler system has been designed and sized by hydraulic calculations in accordance with 2016 NFPA No. 13 and fire authority requirements. Calculations have been included in submittals. Provide current fire flow information from flow test at nearest fire hydrant. Fire flow test shall be done within 6 months of installation of sprinkler system.
- C. Preparation of Drawings and Material Data Sheets: A complete fire sprinkler submittal (drawings, specifications, materials and hydraulic calculations) has been prepared. Hydraulic calculations shall conform to 2016 NFPA 13, paragraph 23.3.5 in all respects.
- D. Coordination Drawings: Contractor shall submit coordination drawings with Contractor title block to Engineer for review, in addition to materials submittals. Deviations between bid documents and coordination drawings shall be specifically noted on drawings (highlighted, clouded, etc.). Any contractor requested design changes to these documents, including layout, materials, or calculations, may be considered a substitution and shall comply with paragraph 1.4 below.

1.3 WORK SPECIFIED ELSEWHERE:

- A. Electrical wiring.
- B. Fire alarm system.
- C. Painting of exposed piping.

1.4 DESIGN CHANGES/SUBSTITUTIONS:

- A. General: Design changes or substitutions of fire sprinkler system shall be submitted to Engineer for review.
- B. Significant changes in design or substitution of materials may require a change order, requiring resubmission to the authority having jurisdiction, as determined by the Engineer. Contractor shall bear all expenses incurred due to preparation and processing of design substitutions, up to and including submission to, and obtaining approval from, authority having jurisdiction. Refer to Section 23 00 00, 1.11, B.
- C. Any substitution of "Flexible" type piping in lieu of "Rigid" pipe or any changes to size, manufacturer or lengths of "Flexible" type piping will require resubmittal of piping plans, product data sheets and hydraulic calculations to Engineer and authority having jurisdiction for review and approval.
- D. Contractor shall submit design or field change(s) through proper channels. Engineer shall have a minimum of 5 working days after receipt of design or field change(s) to submit to DSA. Architect and Engineer shall not be liable for any delays due to DSA review time scheduling, or Contractor's failure to identify changed areas and/or substituted materials in shop drawings and submittals.

PART 2 - PRODUCTS

2.1 STANDARDS:

- A. All materials shall be in accordance with 2016 NFPA No.13 "Standard for the Installation of Sprinkler Systems". Underground mains shall be in accordance with 2016 NFPA No. 24 "Standard for the Installation of Private Fire Service Mains and Their Appurtenances".

2.2 PIPING MATERIALS:

- A. General: The pressure rating of all piping, valves, flanges and other piping accessories shall be in accordance with code and fire authority requirements. Pressure ratings shall exceed the highest possible working pressure.
- B. Piping:

1. Underground: Polyvinyl chloride, Class 200, DR 14, AWWA C900, with rubber ring joints, ASTM D1869. Cast or ductile iron fittings, AWWA C110 or C153, Class 250 or higher, with rubber ring joints, ASTM D1869.
 2. Above Grade:
 - a. 2" and Smaller: Threaded black steel pipe, ASTM A53, schedule 40. 175 psi WOG (min.) black cast iron threaded fittings, ANSI B16.4, UL listed. Unions shall be Class 150 malleable iron threaded, ANSI B16.3.
 - b. 2-1/2" and Larger: Welded black steel pipe, ASTM A53, schedule 10. Standard weight carbon steel welding fittings, ANSI B16.9. Flanges shall be steel, ANSI B16.5. Roll grooved pipe couplings may be used for assembling welded sections, Victaulic, Grinnell, Gruvlok.
- C. Gate Valve:
1. 2" and Smaller: All bronze, rising stem. UL listed.
 2. 2-1/2" and Larger: Iron body, bronze mounted, outside screw and yoke. UL listed. (UL listed butterfly valves may be substituted for 4" and larger gate valves above grade.)
- D. Check Valve:
1. 2" and Smaller: All bronze swing check. UL listed.
 2. 2-1/2" and Larger: Iron body, bronze mounted swing check. UL listed.
- E. Drain Valve: All bronze angle globe valve. UL listed.
- F. Anchors and Hangers: Shall comply with 2016 NFPA No. 13.

2.3 SPRINKLER HEAD:

- A. Automatic sprinkler head, concealed type in areas with finished ceilings and recessed or suspended lighting, semi-recessed in areas with finished ceilings and surface lighting, upright or pendent heads elsewhere (as allowed by NFPA 13). Heads in finished areas shall be Victaulic FireLock V38 quick response concealed, Tyco RFI quick response concealed, or Globe Fire Sprinkler Corp., Quick Response GL Series Concealed Pendent, with chrome-finish metal cover plate. Heads elsewhere shall be quick response, Victaulic FireLock V27, Tyco, Model TY-FRB or Globe Fire Sprinkler Corp., Model GL Quick Response, with standard finish. UL listed. Temperature ratings shall be in accordance with NFPA No. 13. Provide extra heads (of each type installed) in accordance with code requirements. Exposed heads installed with deflector lower than 7'-6" above floor shall have wire guards.

2.4 ALARM VALVE ASSEMBLY:

- A. Standard wet type alarm valve assembly and electric bell complete with trim as required by the authority having jurisdiction. Provide flow switch for connection to alarm system. Provide tamper switch. UL listed. Coordinate with Division 28.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION:

- A. General: Piping shall be concealed in walls, above the ceilings or below grade unless otherwise noted. Exposed piping shall run parallel to room surfaces; location shall be approved by the Architect. No structural member shall be weakened by cutting, notching, boring or otherwise, unless specifically allowed by structural drawings and/or specifications. Where such cutting is required, reinforcement shall be provided as specified or detailed. Depth of cover in traffic areas shall be 36 inches (minimum).
 - 1. Installer Certification: Installation shall be performed by certified fire sprinkler fitter(s) as required by CCR, Title 19, Divisions 1, Chapter 5.5. See CAL FIRE – Office of the State Fire Marshall Information Bulletin 17-002 for more information. The Bulletin can be downloaded from the following: http://osfm.fire.ca.gov/informationbulletin/pdf/2017/IB_AESCert_final_05_25_17.pdf
- B. Standards: All piping shall be installed in accordance with 2016 NFPA No. 13 "Standard for the Installation of Sprinkler Systems". Underground mains shall be installed in accordance with 2016 NFPA No. 24 "Standard for the Installation of Private Fire Service Mains and Their Appurtenances".
- C. Miscellaneous:
 - 1. Escutcheons: Provide chrome plated metal escutcheons where piping penetrates walls, ceilings or floors in finished areas.
 - 2. Pattern: Sprinklers shall be installed in a symmetrical pattern with lighting fixtures and with ceiling pattern. Heads located in lay-in ceilings shall be centered in panel.
 - 3. Pipe Sleeves: All piping passing through concrete shall be provided with pipe sleeves. Allow 1" annular clearance between sleeve and pipe for piping 3" and smaller and 2" annular clearance for piping 4" and larger. Pipes passing between floors shall have Holdrite HydroFlame water/firestop sleeves, UL listed.
 - 4. Access: Provide access doors as required for all valves, devices, etc.
 - 5. Pipes Passing through Fire Rated Surfaces: Pipes passing through fire rated walls, floors, ceilings, partitions, etc. shall have the annular space

surrounding the pipe, or pipe insulation sealed with fire rated materials in accordance with the requirements of 2019 CBC Section 714. Pipes passing through fire rated floors shall have Holdrite HydroFlame water/firestop sleeves, UL listed.

6. Concrete Thrust Blocks: Shall be constructed at all valves, tees, elbows, bends, crosses, reducers and dead ends in loose-joint pipe. Blocks shall cure a minimum of 7 days before pressure is applied. Concrete shall be 3000 psi mix.
7. Electrical Equipment: Piping shall not be run over electrical panels, motor control centers or switchboards, except where specifically allowed by CEC.

3.2 IDENTIFICATION:

- A. All controls, piping, valves and equipment shall be labeled for function and service in accordance with NFPA No. 13 and No. 24.

3.3 TESTS AND ADJUSTMENTS:

- A. Unless otherwise directed, tests shall be witnessed by a representative of the Architect and an inspector of the authority having jurisdiction. Contractor shall notify fire authority at least 48 hours prior to testing. At various stages and upon completion, the system must be tested in the presence of the enforcing agency. Work to be concealed shall not be enclosed until prescribed tests are made. Should any work be enclosed before such tests, the Contractor shall, at his expense, uncover, test and repair all work to original conditions. Leaks and defects shown by tests shall be repaired and the entire work retested. Test all systems in accordance with fire authority requirements and NFPA No. 13 and No. 24.

3.4 CERTIFICATION:

- A. At completion of the project, a Contractor's Material and Test Certificate, indicating installation and testing in accordance with referenced standards, shall be completed. Copies shall be prepared by Contractor for the approving authorities, Owner and Contractor. Deliver certificates to Owner through Architect.

END OF SECTION 21 00 00

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SECTION 22 00 00 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Specification requirements defined in Division 20 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 22. Contractor shall provide the requirements specified in Division 20 to obtain complete systems, tested, adjusted, and ready for operation.

1.2 RELATED WORK

- A. Section 20 00 00 - General Mechanical Requirements
- B. Section 20 05 13 - Motors
- C. Section 20 05 14 - Variable Frequency Drives
- D. Section 20 05 20 - Excavation and Backfill
- E. Section 20 05 29 - Piping and Equipment Supporting Devices
- F. Section 20 05 49 - Seismic Anchorage and Restraints
- G. Section 20 05 53 - Mechanical Systems Identification
- H. Section 20 05 73 - Mechanical Systems Firestopping
- I. Section 20 07 00 - Mechanical Systems Insulation

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 00 00

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SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General Design Information
 - 1. Following is a brief description of the features which should be incorporated in the specifications for various plumbing materials and equipment. Where a specific product is stated with model number, that product should be used as the basis of design and listed as the first named in the specifications. Manufacturers listed without model number are intended to give the designer input on manufacturers whose products have been found to be acceptable.
- B. General Quality Level:
 - 1. Generally, plumbing material and equipment selected should be institutional grade. Long life and simple low-cost maintenance are critical attributes for nearly all University projects. Plumbing fixtures in public areas should also be selected to endure rough use and daily janitorial cleaning.
- C. General-Duty Valves Requirements:
 - 1. Isolation Valves: Provide sufficient number of valves for ease of service, and to reduce inconvenience to users due to outages and draining of systems for minor repairs.
 - 2. Ball valve: Provide with stainless steel ball and stem from and from ½"-1.5" and from 2" up either bronze gate valve or epoxy coated resilient wedge iron body gate valve.
 - 3. Relief valves: Daylight to a conspicuous location. Plumb to sewer.
- D. Identification for Plumbing Piping and Equipment Requirements:
 - 1. Identification Charts: Location should be reviewed and approved by Project Manager in consultation with Facility Services.
 - 2. Piping Service: Identification Tags: Provide with abbreviated legend on 1st line and pipe size on 2nd line. Locate to be visible from exposed points of observation. Where 2 or more pipes run parallel, place printed legend and other markers in same relative location.
 - 3. Valves Service Identification Tags: Provide with abbreviated legend on 1st line and valve service chart number on 2nd line. Identification Charts: Provide two (2) satin finished extruded aluminum frames with rigid clear plastic glazing; 8-1/2 x 11 inches, minimum for each chart. In addition, provide electronic copy of each chart.

- E. Keys for Cabinets and Padlocks:
1. Cabinets and Equipment: Provide 2 keys per panel. Coordinate with Section 08 06 05 - Key Schedule.
 2. Padlocks: Coordinate with Section 08 06 05 - Key Schedule.
 3. Closeout Submittal: Provide panel keys separated and labeled. Provide location, room number, quantity, manufacturer name and model numbers of keys, and coordinate closeout submittal with Section 08 06 05 - Key Schedule.
- F. Testing
1. All new piping shall be tested prior to tie in to existing systems.
 2. Do not test against existing valves when connecting into an existing system. Provide a slip blind at the valve flange or other suitable isolation.
 3. Test gauges shall have 3' minimum dial, with oil fill and gauge cock. Gauge calibration shall be verified to the satisfaction of the University's Inspector prior to commencing testing.
 4. Domestic and Industrial Hot & Cold Water Piping
 5. 150 PSIG test line pressure when connecting to existing system within an existing building for a period of 4 hours using a test medium of water.
 6. 200 PSIG test pressure for a period of 4 hours using a test medium of water for portions of the system which serve both the fire suppression system and the domestic water.
 7. Drain, Waste & Vent Piping Including Lab Waste: 10 feet of head for a period of 1 hour using a test medium of Water.
 8. Natural Gas Piping: 50 PSIG test pressure for a period of 4 hours using a test medium of air.
 9. Compressed Air Piping: 150 PSIG test pressure for a period of 4 hours using a test medium of air.
 10. Pure Water Piping Systems: 100 PSIG test pressure for a period of 4 hours using a test medium of purified water. See 22 05 19 Meters and Gages for Plumbing Piping
 - a. Water meters for domestic water should be nutating disk type sufficiently accurate to record the lowest expected flow (typically the flush of a single low flush toilet). Provide compound metering if necessary to accommodate a large range of flows.
 - b. Provide a permanently piped full size meter bypass on all domestic water services 3" and larger. Valving should be arranged so that the meter can be removed without a disruption of water service.
 - c. All water meters should record in cubic feet.
 - d. Meters for irrigation may be either nutating disk or turbine type depending on expected flow.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 05 00

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SECTION 22 05 33 - ELECTRICAL HEAT TRACING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies materials and installation methods necessary for a thermostatically controlled electrical heat tracing system for grease waste piping, to maintain temperatures sufficient to keep fats oil and grease from congealing and to keep grease liquid and flowing to the grease interceptor.

1.2 RELATED WORK

- A. Section 20 05 29 - Piping and Equipment Supporting Devices
- B. Section 20 07 00 - Mechanical Systems Insulation
- C. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- D. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- E. Section 26 08 00 - Commissioning of Electrical Systems
- F. Section 26 09 00 - Electrical Instrumentation and Controls for Electrical Systems
- G. Section 22 14 00 - Grease Waste and Vent System

1.3 SUBMITTALS

- A. Pre-Construction Submittals: Manufacturer's technical data for each type of product.
 - 1. Heat Tracing Cables, indicating rated capacities, operating characteristics, product approvals.
 - 2. Thermostatic heating cable controller, with temperature recommended by and compatible with the manufacturer's heating cable, including temperature sensors, indicating rated capacities, operating characteristics, product approvals, and numbered circuit schedule, and amperage.
 - 3. Contractor certification from heat trace manufacturer.
 - 4. Sample of the Manufacturer's 10-year extended warranty statement.
- B. Close-Out Submittals:
 - 1. Operation and Maintenance Data; Including Operation and Maintenance Manuals, Testing and Commissioning results recorded in the "Installation and Inspection Record" contained in Section 9 of the manufacturer's Installation and

Operation manual, or other documentation as specified in the contract documents.

2. Contractor shall supply as-built shop drawings as part of the closeout material package, including heat tracing layout, location of GW pipe temperature sensor(s), thermostatic control panels, and electrical power connection points, with schedule of numbered electrical circuits, with circuit length, breaker panel number, breaker number, and electrical load chart for circuits provided.
3. Contractor certification from heat trace manufacturer.
4. Written 10-year extended warranty statement.

1.4 SHIPPING

- A. Package accessory kits in individual plastic bags to prevent loss of components. Subject heat cable to high-frequency spark test and braids to dry dielectric test as instructed by manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Items shall be new, UL Listed or CSA or FM approved for their intended use.

2.2 TEMPERATURE MAINTENANCE HEAT TRACE

- A. Manufacturers: nVent Thermal Management, Chromalox, Thermon or pre-approved equal
- B. Heat Tracing:
 1. Self-Regulating heating cable shall consist of two 16 AWG tinned-copper bus wires imbedded in parallel in self-regulating polymer core, capable of varying its heat output along its entire length. Cable shall be covered by cross-linked polyolefin dielectric jacket, rated for 300 VAC at 221°F with VW-1 flame resistance and protected by tinned-copper braid continuous ground path, with an outer protective jacket of chemically resistant Fluoropolymer.
 2. Heating cable shall operate at 208 V, 240 V, or 277 V, single phase without use of transformers, and capable of maintaining system design temperatures up to 110° F (43° C) in project conditions.
 3. Heat cable cover shall be permanently marked with manufacturer's batch or serial number. Cable jackets shall be continuously marked with manufacturer's name, catalog number, nominal supply voltage and nominal power output in watts per foot in an equally permanent fashion. Use of temporary printing or tags is not allowed.

4. Power retention of heating element shall be minimum of 90% after 72 h exposure in oven at 250°F while energized.
 5. Heat cable shall be capable of withstanding 1,600 VAC RMS (50 or 60 Hz) applied for 1 minute between parallel conductors and metallic braid.
 6. Heat tracing cable Basis of Design shall be Raychem XL-Trace, as manufactured in California by nVent Thermal Management.
- C. Accessories:
1. Include power connection kits, tee kits, end seal kits, splice kits, and thermostatic controllers supplied by same manufacturer as heating cable to protect the product warranty. Include fiberglass tape to fasten heat cable to pipe, heat reflective aluminized tape (as needed), and NEC "Electrically Traced" pipe markers, according to the manufacturer's instructions.
 2. Provide each Heat Tracing circuit with 30mA ground fault protection, incorporated either into the circuit breaker or as an integral part of the thermostatic controller.
 3. Protective electrical conduit, power wiring, junction boxes, and other electrical accessories shall be provided by Division 26 Contractor.
 4. Provide thermostatic heating cable controller with a temperature setpoint from 105°F to 110°F to keep fats oil and grease in GW piping liquid and flowing to the grease interceptor. Controller shall have the following features:
 - a. Digital microprocessor-based heating cable controller with integral 30mA ground fault protection, with pipe temperature sensing, capable of monitoring and remote alarm for high & low temperature, low current or power failure, and ground fault, with both an isolated solid-state triac relay and dry contact relay, and with integral RS-485 communications BMS interface, automatically testing itself with a system check for proper operation. The controller shall be temperature adjustable and the system capable of maintaining up to 110°F system temperature, 100VAC to 277 VAC, single phase, with Nema 4X FRP enclosure. Basis of Design: nVent Raychem model C910-485 with RTD temperature sensor.
 - b. Temperature sensor shall be located on the GW piping, inside of the insulation, the sensor provided with a stainless-steel armored lead with threaded junction box connector, and connected to the controller, or can be extended with three- conductor 22 AWG low voltage shielded instrument cable inside of conduit for extended distance remote temperature sensing.
 - c. Connection kits shall be factory rated NEMA 4X, or connections shall be installed inside of Nema 4X junction boxes, to prevent water ingress and corrosion. All components shall be UV stabilized. Basis of Design Raychem FTC heat shrink or RayClic or FTC heat- shrink connection kits or pre-approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Insure safe handling of all heat tracing cable on the jobsite to prevent cuts breaks, kinks, or abrasions in compliance with the manufacturer's installation instructions.
- B. Inspect and ensure that all pipe, fittings, and pipe support surfaces are clean and free of burrs and sharp edges that could damage the heating cable jacket.
- C. Heating cable applied to underground piping systems shall be of one continuous length, and shall be protected inside of plastic conduit from piping to above ground power connections and terminations completed inside of project approved junction boxes. Cutting, splicing, tee's, or other damage to the heating cable underground will void the manufacturer's warranty.
- D. Insulation for underground piping installations shall be preformed rigid Polyisocyanurate, Calcium Silicate, or FoamGlass, insulation designed for piping systems, provided with a waterproof wrap, or jacketed with PVC, as specified for underground applications, or as recommended by the insulation manufacturer.
- E. Insulation for Above Ground heat traced piping systems shall be Fiberglass, or mineral wool, insulation designed for piping systems, and jacketed as specified for above ground applications, or as recommended by the manufacturer.
- F. The installing contractor shall be responsible to ensure that the insulation size has been selected to allow for sufficient room to cover the pipe and the heating cable without efficiency rodding gaps or compression of the insulation material.
- G. Install heat cable The pipe temperature sensor shall be installed on the pipe, inside of the pipe insulation, and connective wiring shall be protected by electrical conduit up to project approved junction box.
- H. Each Heat Tracing circuit shall be equipped with 30mA ground fault protection, either incorporated either into the circuit breaker provided by Electrical Contractor, or supplied as an integral part of the thermostatic controller.

3.2 INSPECTION

- A. The heating cable system shall be inspected before the system is covered over with insulation to look for damaged heating cable and to ensure the manufacturer's recommended installation instructions have been observed.

3.3 TESTING

- A. The General Contractor and/or the Construction Manager will coordinate with installing contractor and the Electrical contractor to ensure that the heat trace system is tested and energized for proper installed performance as per the manufacturer's Installation, Testing, and Commissioning instructions.
- B. The heat tracing system should be subjected to an "insulation resistance test", a "circuit length verification" test, a "power test", and a "temperature test" as defined in the manufacturer's installation and testing instructions. Recording these test result readings for each circuit.
- C. Contractor shall test continuity of both heater bus wires to verify connection of splices or tees.
- D. Megger heater after thermal insulation has been installed and record readings. Insulation resistance should be at least 20 megohms when measured at 1000 V DC.
- E. If the heating cable circuit fails either insulation resistance or continuity testing, the Electrician shall notify installing Contractor. The installing Contractor must repair or replace circuits yielding unacceptable readings. Megohmmeter testing must be witnessed and documentation of the test report shall be included with the Closing Submittal documents.

END OF SECTION 22 05 33

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SECTION 22 05 48 - VIBRATION, NOISE AND SEISMIC CONTROLS FOR PLUMBING EQUIPMENT AND PIPING

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.
- B. In the event of conflict regarding mechanical vibration control requirements between this Section and any other Section, the most conservative provision shall govern.

1.2 COMMISSIONING

- A. Comply with the requirements of Specification Section 01 91 13 COMMISSIONING REQUIREMENTS for the commissioning of the various building systems.

1.3 SUMMARY

- A. This Section specifies the requirements for vibration control systems to be used in all phases of mechanical work.
- B. This Specification provides the necessary design for the avoidance of excessive vibration in the building due to the operation of machinery or equipment and/or due to interconnected piping, conduit, or structures.
- C. Due to the nature of this facility the design criteria may exceed those of normal industrial construction. It is imperative that close attention be paid to all specifications and details for noise and vibration control.
- D. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Spring isolators.
 - 5. Elastomeric hangers.
 - 6. Spring hangers.
 - 7. Pipe riser resilient supports.
 - 8. Resilient pipe guides.
 - 9. Seismic snubbers.
 - 10. Restraining braces and cables.

11. Vibration isolation equipment bases.

1.4 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.5 RELATED WORK

- A. This Section shall be in conjunction with the following specifications and related Contract Documents to establish the total requirements for mechanical vibration control.
 1. Section 22 00 00 - Basic Plumbing Requirements
 2. Table 22 05 48 - Vibration Isolation Schedule.

1.6 CONTRACTOR'S GENERAL RESPONSIBILITIES

- A. The Contractor shall bring to the Architect's attention prior to installation any conflicts which will result in unavoidable contact between the building structure and the isolated equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at the expense of the responsible contractor.
- B. The Contractor shall bring to the Architect's attention prior to installation any discrepancies between the requirements of this Specification and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation shall be at the expense of the responsible contractor.

1.7 DESIGN AND INSTALLATION CRITERIA

- A. Equipment, piping and conduit shall not be installed which makes rigid contact with the structure or rigidly-connected building components unless it is allowed by this specification.
- B. Pipe Anchors and Supports: Piping supports and anchors shall not interfere with free operation of vibration isolation systems.
- C. Systems, equipment, or parts which generate uncharacteristically high levels of noise or vibration while in operation, shall be (1) adjusted, repaired, or replaced as appropriate to obtain acceptable levels of vibration or noise, or (2) be supported on, or fitted with,

suppression or absorption devices, or other means, which effectively prevent the transmission of vibration or noise beyond the offending item.

- D. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for all isolated piping, conduit, etc. Provide resilient sealant to maintain the sound transmission characteristics of acoustically rated partitions. Refer to resilient penetration details on the Drawings.
- E. Pipe a flow velocities: The following guidelines for flow velocity shall be followed, unless superseded by the more stringent requirements of other specifications.
 - 1. Maximum liquid flow velocities anywhere shall not exceed 9 fps (3 m/s)

1.8 COORDINATION

- A. The Work under this Section must be coordinated with all other mechanical, electrical, architectural, and structural work in order to accomplish the interfacing necessary to provide a complete and operating system in conformance with the requirements of the Contract Documents.

1.9 PERFORMANCE REQUIREMENTS

- A. Contractor shall comply with the following design characteristics:
 - 1. Site Class as Defined in the IBC.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC
 - a. Component Importance Factor:
 - b. Component Response Modification Factor:
 - c. Component Amplification Factor:
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
 - 4. Design Spectral Response Acceleration at 1-Second Period:

1.10 SUBMITTALS

- A. Provide the following in addition to the standard requirements:
 - 1. A general statement of materials and methods intended for use on this project. Specific information shall be provided for all items described under the products section of this Section. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weight and interface description with other work, shall be supplied. Complete performance data are required that shall indicate full compliance with specifications as outlined.
 - 2. Complete detailed shop drawings showing the intended locations and construction features of all types of products specified. Shop drawings shall be submitted in a timely manner.

3. Catalog cutsheets and data sheets on specific vibration isolators shall be provided showing compliance with the specification.
 4. Detailed selection data for each vibration isolator supporting equipment or piping, including:
 - a. The equipment identification mark.
 - b. The isolator type and model number.
 - c. The actual operating load at each support point including all support equipment, piping, and thrust loads.
 - d. The static deflection expected under the actual operating load.
 - e. The specified minimum static deflection.
 - f. The additional deflection to solid under operating load.
 - g. The ratio of spring height under actual operating load to spring diameter.
 5. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, and support point locations.
 6. Written approval of the frame design to be used shall be obtained from the equipment manufacturer.
 7. Drawings showing methods for suspension, of support, and guides.
 8. Drawings showing methods for isolation of piping at penetrations of walls, slabs, and beams.
 9. Product data to 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 agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 10. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined operating loads.
- B. Delegated-Design Submittal: For 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 their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 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. Seismic and Wind Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the 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.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings: Show coordination of seismic bracing of piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates.
- E. Qualification Data: For professional engineer and testing agency.
- F. Field quality-control test reports.

1.11 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or

preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Acceptable Manufacturers: Subject to compliance with requirements, All products shall be supplied by one of the following approved manufacturers or manufacturers that meet all of the requirements of this spec:
1. Kinetics Noise Control Inc. (Kinetics), Dublin, Ohio.
 2. Mason Industries, Inc. (Mason), Hauppauge, New York.
 3. The VMC Group (V.M.C.), Bloomington, New Jersey.
- B. General:
1. Metal parts of vibration-isolation units shall be treated per manufacturer's specifications for corrosion resistance (e.g. galvanized, epoxy coated, painted, etc.) and in accordance with other Specification Sections.
 2. Elastomeric isolators may be composed of natural rubber or neoprene. Natural rubber shall be used unless this material is incompatible with the installation environment.
 3. All isolators installed outdoors shall have base plates with bolt holes for fastening the isolators to the support members.
 4. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevation during installation and initial system filling operations, and similar installation advantages. Accessories shall not degrade the vibration isolation system.
 5. Static deflection of isolators shall be as indicated in Table 22 05 48 - Vibration Isolation Schedule. All static deflections stated are the minimum acceptable deflection for the mounts under actual operating load.
 6. The use of housed springs, nested springs or of multiple parallel springs within a single mount is not permitted.
- C. Type FSN (Free-standing Floor Spring):
1. Spring isolators shall be free-standing and laterally stable without any housing. Spring diameter shall be not less than 0.8 times the compressed height of the

- spring at the design load. Springs shall have a minimum additional travel to solid equal to 50 percent of the actual deflection. Springs shall be designed so that the ratio of horizontal stiffness to vertical stiffness is approximately 1. All mounts shall have leveling bolts.
2. The spring element in the isolator shall be mounted on a Type DNP isolator. A rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's range shall be provided. If the spring isolator is supplied with an elastomeric friction pad, a stainless steel, aluminum, or galvanized steel plate shall be used between the friction pad and the DNP isolator.
 3. If the isolator is to be fastened to the building structure and a Type DNP isolator is used under the bearing plate, elastomeric grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly to the grommet. Bolts and washers shall be galvanized.
 4. Type FSN isolators shall be one of the following products, or approved equal, with the appropriate elastomeric pad selected from Type DNP:
 - a. Model SLF, SLFH: by Mason
 - b. Model FDS: by Kinetics
 - c. Model AC, ACB, ADC, ADCB, AWHC: by V.M.C.
- D. Type FSNTL (Travel Limited Free-standing Floor Spring):
1. Spring isolators shall be free-standing and laterally stable without any housing. Spring diameter shall be not less than 0.8 times the compressed height of the spring at the design load. Spring shall have a minimum additional travel to solid equal to 50 percent of the actual deflection. Springs shall be designed so that the ratio of horizontal stiffness to vertical stiffness is approximately 1. All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as a structural support during erection of the equipment. A minimum clearance of 1/4 inch (6 mm) shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
 2. The spring element in the isolator shall be mounted on a type DNP isolator. A rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's range shall be provided. If the spring isolator is supplied with an elastomeric friction pad, a stainless steel, aluminum, or galvanized steel plate shall be used between the friction pad and the DNP isolator.
 3. If the isolator is to be fastened to the building structure and a Type DNP isolator is used under the bearing plate, elastomeric grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly to the grommet. Bolts and washers shall be galvanized.

4. Type FSNTL isolators shall be one of the following products, or approved equal, with the appropriate elastomeric pad selected from Type DNP:
 - a. Model SLR (welded restraint type): by Mason
 - b. Model FLS: by Kinetics
 - c. Model AWRS: by V.M.C.

- E. Type FN (Elastomer-in-shear Floor Isolator):
 1. Elastomeric isolators shall be elastomer-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with elastomer. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener.
 2. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
 3. Type FN isolators shall be one of the following products or approved equal:
 - a. Model ND: by Mason
 - b. Model RD: by Kinetics
 - c. Model R/RD: by V.M.C.

- F. Type NP (Elastomeric Pad)
 1. Elastomeric pad isolators shall be one layer of 1/4-inch (6 mm) to 3/8-inch (10 mm) thick ribbed or waffled material. Elastomer shall be 30 to 70 durometer. The pads shall be sized so that they achieve a minimum static deflection of 15 percent of the pad thickness under full operating load and shall not be loaded above the manufacturer's recommended maximum load.
 2. Type NP isolators shall be one of the following products or approved equal:
 - a. Model Mini Super W: by Mason
 - b. Model NPS or NPD: by Kinetics
 - c. Model Shear-Flex: by V.M.C.

- G. Type DNP (Double Elastomeric Pad):
 1. Elastomeric pad isolators shall be one layer of 3/4-inch (19 mm) thick ribbed or waffled material or formed by two layers of 1/4-inch (6 mm) to 3/8-inch (10 mm) thick ribbed or waffled material. Multiple layers shall be separated by a stainless steel or aluminum plate and shall be permanently adhered together. Elastomeric material shall be 30 to 70 durometer. The pads shall be sized so that they achieve a minimum static deflection of 15 percent of the pad thickness under full operating load and shall not be loaded above the manufacturer's recommended maximum load.
 2. Type DNP isolators shall be formed from one of the following products or approved equal:
 - a. Model Super W or Multiple Layers of W or Mini Super W: by Mason
 - b. Model RSP or NGS: by Kinetics

- c. Model Maxi-Flex or Multiple Layers of Shear Flex: by V.M.C.

- H. Type HS (Hanger Spring):
 - 1. Vibration-isolation hangers shall consist of a free-standing laterally stable steel spring set into an elastomeric cup, contained within a steel housing. The elastomeric cup shall be manufactured with a grommet (or other element) to prevent the hanger rod from contacting the hanger housing.
 - 2. Spring diameter and hanger housing hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the housing. Spring elements shall have minimum additional travel to solid equal to 50 percent of the actual deflection.
 - 3. Upper hanger rod attachment shall be made through an elastomeric rubber-in-shear element designed to avoid direct contact between the hanger rod and the isolator frame.
 - 4. Springs shall be color coded for ease of identification.
 - 5. Type HS isolators shall be one of the following products or approved equal:
 - a. Model 30N: by Mason
 - b. Model SRH: by Kinetics
 - c. Model HRSA: by V.M.C.

- I. Type HN (Elastomeric Hanger):
 - 1. Vibration-isolation hangers shall consist of an elastomeric-in-shear element contained in a steel housing. An elastomeric neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The hangers shall be loaded within the manufacturer's recommended range.
 - 2. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30 degree arc before contacting the bushing.
 - 3. Type HN isolators shall be one of the following products or approved equal:
 - a. Model HD: by Mason
 - b. Model RH: by Kinetics
 - c. Model HR: by V.M.C.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

- A. Acceptable Manufacturers: Subject to compliance with requirements, All products shall be supplied by one of the following approved manufacturers:
 - 1. Kinetics Noise Control Inc. (Kinetics), Dublin, Ohio.
 - 2. Mason Industries, Inc. (Mason), Hauppauge, New York.
 - 3. The VMC Group (V.M.C.), Bloomingdale, New Jersey.

- B. Type BSF (Base Steel Frame):

1. Steel base frames shall consist of structural steel sections sized, spaced, and connected to form a rigid base which will not twist, deform, or deflect in any manner which will negatively affect the operation of the supported equipment or the vibration-isolation mounts.
 2. Frames shall be adequately sized to support basic equipment units and their supports, plus any associated pipe elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. The depth of steel frame bases shall be at least 1/10 of the longest dimension of the base with a minimum depth of 6 inches (150 mm), but not more than 12 inches (300 mm).
 3. Frame bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
 4. Type BSF base shall be supplied by the isolator manufacturer and shall be one of the following products or approved equal:
 - a. Model WFSL: by Mason
 - b. Model SFB: by Kinetics
 - c. Model WFB: by V.M.C.
- C. Type BIB (Base Inertia Base):
1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 pounds per cubic foot) (2,400 kilograms per cubic meter) and appropriate steel reinforcing cast between perimeter structural steel channels. Inertia bases shall be built to form a rigid base which will not twist, deform, or deflect, in any manner which would negatively affect the operation of the supported equipment or the vibration isolation mounts.
 2. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 of the longest dimension of the inertia base, but not less than 6 inches (150 mm) and not more than 12 inches (300 mm).
 3. The weight of the inertia base, as a minimum, shall be equal to or greater than that of the total weight of the equipment (including the attached piping and fluids the base is supporting and other applicable static and dynamic loads). In special applications such as reciprocating compressors, the inertia base weight requirement could be higher and shall be calculated on a case-by-case basis.
 4. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
 5. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Concrete shall be provided by the appropriate Subcontractor.

6. Inertia bases used to support vibration-isolated pumps shall be sized to provide support for pipe elbows and suction diffuser.
7. Frame and reinforcement for Type BIB bases shall be one of the following products or approved equal:
 - a. Model KSL or BMK: by Mason
 - b. Model CIB-L or CIB-H: by Kinetics
 - c. Model WPF or MPF: by V.M.C.

2.3 FLEXIBLE CONNECTORS

- A. Flexible Pipe Connections: Flexible pipe connectors shall be fabricated of Kevlar or nylon cord, fabric, and elastomer. Flexible pipe connections shall result in a flexible and highly compliant connection that can allow longitudinal, transverse, and angular movements and provide micro- vibration isolation. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. Rods or cables, installed with appropriate elastomeric grommets, may be used to control extension of the connector if required by the manufacturer, but shall not inhibit movement necessary to provide sufficient vibration isolation. Flexible pipe connections shall be one of the following products or approved equal:
 1. Model SFDEJ: by Mason
 2. Double Sphere (Model DS): by Metraflex
 3. Model VMT: by V.M.C.
 4. Model FTC: by Kinetics
- B. Flexible Conduit Connections: Flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip. Liquid-tight flexible conduit shall be formed of one continuous length of electro-galvanized spiral-wound steel strip, with elastomeric gasket.

2.4 RESILIENT PENETRATION SLEEVE/SEAL

- A. Resilient penetration sleeve/seals shall be field fabricated from a pipe or sheet metal section that is no more than 1 inch (25 mm) larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated. The actual penetration shall be no more than 1 inch (25 mm) larger in each dimension than the sleeve. The sleeve shall extend 1 inch beyond the penetrated construction on each side. Seal the gap between the penetration and the sleeve airtight with non-shrinking non-hardening acoustical caulk. The annular space between the sleeve and the penetrating element shall be packed with glass fiber or mineral wool to within 1/4 inch of the end of the sleeve. The remaining 1/4 inch (6 mm) space on each side shall be filled with non-shrinking non-hardening acoustical caulk to form an

airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve.

- B. Adjustments to any vibration isolators may be required in order to accomplish this. Alternatively, a prefabricated sleeve (Mason Industries Type SWS or equal) that accomplishes the same result is acceptable. Coordinate with penetration details shown on the Drawings.

2.5 RESILIENT LATERAL GUIDES

- A. These units shall incorporate elastomeric isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising pipes.
- B. Resilient lateral guides shall be one of the following products or approved equal:
 1. Model ADA : by Mason
 2. Model KPA : by Kinetics
 3. Model AG : by V.M.C.

2.6 SEISMIC-RESTRAINT DEVICES (TO BE REVIEWED BY STRUCTURAL ENGINEER)

- 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 following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti, Inc.
 5. Kinetics Noise Control.
 6. Loos & Co.; Cableware Division.
 7. Mason Industries.
 8. TOLCO Incorporated; a brand of NIBCO INC.
 9. Unistrut; Tyco International, Ltd.
- D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by OSHPD or 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 four times the maximum seismic forces to which they will be subjected.
- E. Snubbers: Snubbers to limit the vertical and horizontal motion of the isolated equipment under seismic load shall be 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 a minimum 1/4-inch- (6-mm-) thick elastomeric pad shall be affixed at the point of contact.
 4. There shall be no contact between snubbers and the inertia base or equipment support frame during normal operation. Snubbers must allow clear inspection of the non- contacting elements. The purpose of this requirement is to avoid short circuiting of the isolation system by the snubber system.
 5. Snubber designs in compliance with the intent of this Section include:
 - a. Mason Industries: Model Z-1225
 - b. Kinetics Noise Control: Model HS-1, HS-2, or HS-5
- F. 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.
- G. Restraint Cables: ASTM A 603 galvanized ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Seismic restraint cables shall be of a design, such as slack multi-strand aircraft cables, that can be installed and adjusted to function without interfering with the isolation systems.
- H. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.
- I. 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.
- J. 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.

- K. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water- resistant neoprene, with a flat washer face.
- L. 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 E 488. Minimum length of eight times diameter.
- M. 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 E 488.

2.7 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall obtain inspection from the Architect of any installation to be covered or enclosed prior to such closure.
- B. The Contractor shall obtain written and/or oral instructions from the vibration isolation and seismic-control device manufacturer as to the proper installation and adjustment of such devices.
- C. The Contractor shall correct, at no additional cost, all installations which are deemed defective in workmanship or materials by the Architect.
- D. The Contractor shall be responsible for proper operation of all systems, sub-systems, and services provided under this Section. The Contractor shall coordinate startup

procedures, calibration, and system check-out with all sub-contractors involved. Any system operational problems shall be diagnosed. All correctional procedures shall be initiated by the various contractors as required to bring the system into compliance with the design, and the problem shall then be rechecked to verify that the system operates normally. Any remaining difficulties shall be brought to the attention of the Architect.

3.2 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.

3.3 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by OSHPD or an agency acceptable to authorities having jurisdiction.
- 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.

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. The installation or use of vibration isolators or seismic-restraint device must not cause any change of position of equipment, conduit, or piping which would result in stresses in connections or misalignment of shafts or bearings. In order to meet this objective, equipment and attached systems shall be maintained in a rigid position during installation. Equipment weight shall not be transferred to the isolator until the equipment installation is complete and under full operational load.
- B. All plumbing and piping at mechanical equipment connections is to be fully supported by specified hangers. Plumbing and piping loads shall not be carried by plumbing equipment and its vibration mounts, unless otherwise required by this Specification.

- C. Vibration isolators supporting equipment or piping shall be selected to have a stiffness at least ten times less than that of the building structural, or non-structural, components that support the isolators, or as directed by the vibration consultant. Vibration isolators must also comply with the requirements of this Section and the required minimum static deflection indicated in this Section or in Table 22 05 48 - Vibration Isolation Schedule.
- D. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- E. Equipment Isolator Installation:
 - 1. Height-saving brackets shall be used for equipment supported on Type FSN vibration isolators.
 - 2. The minimum operating clearance between the underside of the frame or inertia base and the pad or floor shall be 1 inch (25 mm).
 - 3. The frame shall be placed in position and supported temporarily by shims prior to the installation of the machine or isolators.
 - 4. After the entire system installation is completed and under full operational load, the isolators shall be adjusted so that the load is transferred from the shims to the isolators. When all isolators are properly adjusted, the shims will be barely free and shall be removed.
 - 5. Except for the possible use of temporary snubbers during construction, seismic snubbers shall not receive final adjustment until vibration isolators are in-place and adjusted with actual operating loads.
- F. Isolator Hangers
 - 1. The isolators shall be installed with the isolator hanger box as close as possible to the structure but not in contact with the building structure.
 - 2. The isolators shall be suspended from the stiffest portions or element of the structure above. In framed construction, this consists of beams and girders.
 - 3. Orientation of isolator assembly including support and load rods shall be within five degrees of vertical.
- G. Equipment Restraints:
 - 1. Indicate type and quantity of snubbers described in first subparagraph below on Drawings or in the Plumbing Vibration-Control and Seismic-Restraint Device Schedule on Drawings.
 - 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 OSHPD or an agency acceptable to authorities having jurisdiction providing required submittals for component.

- H. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 - 3. Brace a change of direction longer than 12 feet (3.7 m).
- I. Install cables so they do not bend across edges of adjacent equipment or building structure.
- J. Install seismic-restraint devices using methods approved by OSHPD or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- L. 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.
- M. 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.
- N. 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.

3.5 EQUIPMENT ISOLATION

- A. Install isolators for fans, chillers, compressors, pumps and other such equipment as detailed in the Table 22 05 48 - Vibration Isolation Schedule or as otherwise required. Unless otherwise specified in the Vibration Isolation Schedule or reviewed in advance by the Architect, no equipment of more than 3 horsepower (2 KW) shall be attached to the structure without suitable vibration isolation. Where piping or conduit connects to such equipment, provide flexible connectors as specified in Specifications or shown on the Drawings.
- B. Mechanical equipment manufacturer shall approve complete vibration isolation system for all isolated equipment.

3.6 PIPING ISOLATION

- A. Provide resilient wall and ceiling penetrations with sleeves for all piping, conduit, etc. Refer to resilient penetration details on Drawings.
- B. Pipe support isolation shall comply with the following general guidelines:
 - 1. Specified Extent of Isolation: Piping, 2 inches in diameter or greater, which is connected to vibration isolated equipment shall be isolated from the building structure (defined as any rigid building elements, such as normal structure; walls, whether load-bearing or not; and any other rigid components attached to the structure) using resilient supports, pipe guides, and penetration sleeves (as applicable) for a distance of 25 feet or 50 pipe diameters, whichever is greater.
 - 2. Spring isolators shall be selected for a static deflection, under load, of not less than 1 inch (25 mm). Type FSN or HS isolators (whichever is applicable to the mounting condition) shall be used.
 - 3. Where lateral support of pipe risers is required within the specified limits of isolation, this shall be accomplished by use of Type FSN, or resilient lateral supports with the specified minimum static deflection.
 - 4. Pipes that penetrate the building structure within the specified extent of isolation shall be isolated from the structure by use of resilient penetration sleeves and seals.
 - 5. Drain piping connected to vibration-isolated equipment shall not rigidly contact the building structure or other non-isolated system.
 - 6. Piping connected to vibration-isolated equipment shall be installed so that it does not strain or force out of alignment pipe flexes or vibration isolators supporting either the equipment or the piping.
 - 7. Where pipes are racked together, the most stringent isolation requirement, as defined in this Section shall take precedence.

8. **Passive Mechanical Equipment:** Passive mechanical equipment refers to equipment without motors such as cooling coils, heat exchangers, etc. For passive mechanical equipment connected to vibration-isolated mechanical equipment by piping of length less than 25 feet (8 m) or 50 pipe diameters, whichever is greater, with a diameter equal to or greater than 2 inches (50 mm):
 - a. Provide vibration isolation flexible pipe connections at passive equipment.
 - b. Support pipe connections between mechanical and passive equipment on hanger with the same type and deflection as the mechanical equipment support.
9. Unless otherwise required in this Section, gas, gravity drain, and fire protection piping are exempt from vibration isolation requirements.

3.7 EQUIPMENT BALANCE REQUIREMENTS

- A. All rotating equipment shall operate at speeds less than 80 percent of their true critical speed. Unless otherwise required, equipment shall be balanced according to the recommendations given in the following sections. If balance requirements exist in other Sections, the more stringent requirement shall apply.
- B. Equipment components such as motors, pump rotors, etc. shall be factory balanced, both statically and dynamically, to meet the field balance requirements described below.
- C. **Balance Criteria:** Pumps, compressors, and other rotating equipment shall be field tested in accordance with International Standard ISO 10816-1 and 10816-3 or ANSI Standard S2.41 (current edition) by an independent company after installation and under actual operating conditions. Vertical and horizontal vibration of rotating equipment shall not be greater than 0.07 inches/sec RMS (0.1 inches/sec 0-peak) [1.8 mm/sec RMS (2.5 mm/sec 0-peak)] velocity. The vibration shall be measured on the equipment bearing caps when the equipment is mounted on its vibration isolation mounts. A balance report will be provided for each item of equipment.
- D. **Inertia Base or Skid-Mounted Equipment Balance:** The weight of inertia bases or skids (and of any other components mounted on the same inertia base or skid) will reduce the vibration response when equipment is balanced. Therefore, the balance criteria shall be multiplied by the following factor for such equipment:

$$\text{Factor} = \frac{W}{WT+W}$$

Where

WT = Inertia weight (base + other components)

W = Weight of the subject equipment

3.8 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. Comply with requirements in Division 22 Section "Hydronic Piping" for piping flexible connections.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. 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 at least 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.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.10 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 active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 22 05 48

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SECTION 22 05 94 - DOMESTIC WATER SYSTEMS BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 22 11 18 - Water Distribution System
- B. Section 22 21 14 - Plumbing Specialties

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Plumbing Contractor shall be responsible for providing complete testing and balancing work of liquid fluid handling systems, such as domestic hot water return, laboratory hot water return, water mixing valves, and other processes included in this Project.
- B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports as specified herein.
- C. Scope of work includes new work specified herein and includes all equipment, distribution systems, and terminal units connected.
- D. Scope of work also includes CALgreen required testing, adjusting and balancing of water heating systems.
- E. Work is limited to new areas within construction boundaries and does not include central pumping equipment or other areas. Adjust and balance flows to values indicated or scheduled. If flow is abnormal, attempt to proportional balance flows to the same percentage below design and contact Owner's Representative for additional instruction.
- F. Procedures shall be in accordance with the latest edition of AABC or NEBB and as per detailed herein.
- G. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractors who are members of AABC or NEBB and who have qualified

personnel available to perform work may submit Quality Assurance Submittal for approval.

- H. Contractors who are members of AABC or NEBB and who have qualified personnel available to perform Work may submit Quality Assurance Submittal for approval. Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.
- I. Owner will separately contract with an independent TAB Contractor to perform all testing, adjusting and balancing of HVAC hydronic systems required for this Project. Work related to testing, adjusting, and balancing that must be performed by Mechanical Contractor is specified in other sections of these Specifications.
- J. Upon direction of Owner's Representative or TAB subcontractor, Contractor shall provide (at no additional cost to the Owner) any additional work and/or devices necessary to properly balance the system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at minimum pressure differential.
- K. TAB work shall not proceed until all assigned personnel have been approved by, Owner's Representative via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be complete before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Owner's Representative.

1.4 SUBMITTALS

- A. General:
 - 1. Make submittals in accordance with Section 01 33 00 - Submittals. Submit minimum of 5 copies of all submittals unless otherwise directed.
 - 2. Reports shall be assembled using a 3-ring hard cover binder with Project Name and location on the cover and the side panel. Information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Assemble report in the following order.
 - a. Transmittal letter
 - b. Cover sheet with Project title, location, submittal date, and names and addresses of Owner, Contractor, TAB subcontractor, Architect, and Engineer
 - c. Index of numbered tabs listing major systems
 - d. Data organized by system in the following order:
 - 1) Equipment data and measurement summary

- 2) Equipment measurement data
 - 3) Branch main measurement data
 - 4) Terminal device measurement data
 - e. Provide numbered tabs for each system.
- B. Quality Assurance Submittal:
 1. Within 30 days of signing Contract, Contractor shall submit the following information:
 - a. Firm resume
 - 1) AABC or NEBB active membership required
 - 2) Names of 3 recent relevant completed projects along with the project address, Owner's contact person, supervising design professional.
 - b. Supervisor resume
 - c. Balance technician(s) resume
 2. Owner Representative and Owner reserve the right to contact previous project representatives and to reject persons whom Owner Representative and/or Owner feel are not qualified for this Project due to lack of relevant experience or problems on previous projects.
- C. Planning Report:
 1. Submit Planning Report as detailed in Part 3-EXECUTION of this Section to demonstrate to Owner Representative that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before fieldwork starts.
- D. Initial Test Report:
 1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to A/E and Contractor incomplete work or problem areas to be resolved before final balance is completed.
- E. Final Report:
 1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.5 REFERENCE STANDARDS

- A. Refer to the latest publications of the NEBB, the American Society of Plumbing Engineers (ASPE) and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.
- B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Owner Representative upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards.

PART 3 - EXECUTION

3.1 GENERAL

- A. TAB work shall be done in separate phases as outlined herein. Project schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.
- B. Set point for individual branch balancing valves in domestic hot water return, laboratory hot water return, tepid water systems shall be 0.5 gpm unless otherwise noted on drawings or schedules.
- C. Set point for domestic hot water return and laboratory hot water return circulating pump shall be the flow rate defined in schedules on drawings.

3.2 PLANNING PHASE

- A. Procedure:
 - 1. Obtain latest contract documents including addenda and change orders. Obtain shop drawings and performance curves from Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.
- B. Planning Report:
 - 1. Planning Report shall contain the following minimum requirements.
 - a. Narratives:
 - 1) Provide written narratives of procedures used. Provide separate narratives for each pump and liquid fluid handling system.

- 2) Identify flow-measuring devices to be used at each pump and terminal device. Provide different narratives for constant and variable flow systems.
 - 3) For non-standard water systems, include narratives on how to measure and adjust for different viscosities.
 - 4) Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances. For this Project, minimum acceptable is $\pm 10\%$ of design flow.
- b. Prebalance Checklist: include, but not limited to:
- 1) Check for completeness of work
 - 2) System cleaning
 - 3) System fill and air venting
 - 4) Place system into operation
 - 5) Check expansion tanks and fill pressures
 - 6) Pump bearings, alignment, starters, vibration isolators, rotation
 - 7) Setting valves to proper position including shutoff and bypass valves
 - 8) Set up of controls and control devices
- c. Measuring Instrument List: list measuring instruments to be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
- 1) Manufacturer name and model number
 - 2) Measurement range
 - 3) Pressure/temperature limits
 - 4) Date put into service
 - 5) Date of last calibration
 - 6) Include certificate from calibration firm
2. Owner's Representative reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within the past year.
 3. Samples: Submit copies of TAB forms to be used.
 4. Branch circuit and terminal measurements: indicate on pre-printed forms of AABC or NEBB measurements to be taken in the field. Include branch circuit or terminal identification, system, space served, location, design flows (include zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate initial setpoint on forms.

3.3 SET-UP PHASE

- A. Procedure:
1. Perform prebalance checkout as per Planning Phase narrative.

- B. Initial Test:
 - 1. Measure pump data and flows in "as found" condition after initial valve settings are made.

- C. Initial Test Report:
 - 1. Submit report to Owner's Representative and Contractor indicating measurements made and make notes of items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

- A. Procedure:
 - 1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required before submitting Final Report.

- B. Final Report:
 - 1. Submit report to Owner's Representative and to Contractor indicating data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

- C. Final Report Adjustments:
 - 1. Owner's Representative reserves the right to check any measurement made and to reject any portion of work not within the design tolerance of $\pm 10\%$ of design flow. Contractor shall resubmit all or portions of Final Report as directed by Owner's Representative.

END OF SECTION 22 05 94

SECTION 22 10 05 - PLUMBING PIPNG

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Flanges, unions, and couplings.
 - 4. Pipe hangers and supports.
 - 5. Manufactured sleeve-seal systems.
 - 6. Valves.

1.2 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping 2017.
- B. NSF 61 - Drinking Water System Components - Health Effects 2017.
- C. NSF 372 - Drinking Water System Components - Lead Content 2016.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

PART 3 - EXECUTION

3.1 GENERAL STANDARDS

- A. All underground plumbing utility piping shall have a minimum of 12" sand encasement.
- B. All underground plumbing utility piping shall have a minimum depth of 24" unless otherwise approved by the administrative authority after all existing utilities have been potholed by the contractor.

3.2 DESIGN DOCUMENTATION

- A. Programming; For wet laboratories, studios, dark rooms, commercial kitchens, laundries, and other special use rooms requiring plumbing utilities to accommodate special functions, the Design Professional shall gather and document all information required to confirm Plumbing requirements as part of room programming. This information shall be included with the Design Development Submittal. Obtain and document the following information for each building room where special use plumbing services will be required.
1. Room name
 2. Person requesting the plumbing services, Interviewer, Date
 3. Room use
 4. A list of required plumbing services. Include qualitative and quantitative data if available.
 5. Functions / processes which the required plumbing services are intended to accommodate. Provide sufficient information to ascertain the need for special plumbing provisions such as back flow prevention, pressure regulation, drain sediment traps, etc.
 6. A list of all equipment / apparatus which will require plumbing services. Include equipment manufacturer's data (connection size, use rate, etc.) if available.
 7. The above programming information may be omitted for rest rooms and residential kitchens where all required design data is covered by applicable codes.

3.3 PLUMBING CALCULATIONS:

- A. The Design Professional shall include final plumbing calculations with the 50% Working Drawing submittal. These calculations shall include the following:
1. The room programming documents covered above.
 2. All assumptions clearly stated. In particular, document assumptions that had to be made in order to proceed with the design in the case of insufficient data being provided by the users. The intent here is to flag assumptions which the University should verify as correct.
 3. Applicable code requirements
 4. Tabulated design criteria for each plumbing service by system including:
 - a. System
 - b. Location of Service (Room number)
 - c. Required flow quantity for each location including: water use fixture units, drainage fixture units, GPM flow rates for specialized equipment, natural gas load by both BTU/HR and CFH, CFH for air, vacuum and specialized gasses.

5. Calculated data as required to select each piece of plumbing equipment including:
 - a. Hot water heater demand and storage capacity.
 - b. Sump pump sizing data,
 - c. Lift station sizing data,
 - d. Circulation pump sizing data.
6. Pipe sizing data including: combined flow for each pipe run, developed length for each pipe run, selected pipe size based on stated criteria (sizing chart, pressure drop, fluid velocity, etc. This data may be either in tabulated form or rough pipe schematic.
7. Rainwater leader calculations

3.4 PLUMBING WORKING DRAWINGS

- A. General: Plumbing Working Drawings shall be sufficiently complete to assure high quality, fully functional plumbing systems, no contractual ambiguity, and also shall serve as a long-term record of the building's plumbing systems. The following guidelines apply to all Plumbing.
 1. No work shall be called out in a manner which is not contractually enforceable. Plumbing quality level shall be fully identified to assure fair competitive bidding as well as a quality installation.
 2. Design / build format for the plumbing section of the work as is sometimes used in residential plumbing construction shall not be used on Cal Poly projects. An exception to this guideline shall be the case of the entire building project being design / build format when approved by the University's Representative.
 3. All points of connection to existing piping systems shall be identified. Verify points of connection by potholing where required.
 4. All piping shall be sized.
 5. The routing of all piping shall be indicated. The indicated routing shall be verified to be feasible within the furring spaces indicated in the architectural drawings.
 6. All equipment and fixtures shall be located. Maintenance access space as recommended by the manufacturer shall be indicated on the drawings.
 7. All piping penetrations of the building shell shall be indicated.
 8. Concrete core drills of existing structures shall be identified.
- B. Provide a Plumbing Legend covering all symbols and abbreviations used in the plumbing drawings in order to have a fully enforceable contract.
- C. Provide a Plumbing Schedule covering factory assembled plumbing equipment and fixtures. The intent should be the easy determination of the plumbing equipment included in the project to encourage competition among comparable product suppliers. Note that when a product manufacturer's name and model are called out on the schedule to serve as the basis of design, the specifications must be also be

coordinated so that the same manufacturer is the first specified. See Division 1 Section of Cal Poly's standard for Product Options and Substitution Request procedures for further information.

- D. Provide Plumbing Floor Plans to scale for each level where plumbing services are to be provided. Provide enlarged partial plans for congested areas such as public rest rooms where the normal scale plans will not adequately depict the work.
- E. Sections to scale should be provided when the vertical arrangement of equipment and piping relative to other building components is critical for proper function or adequate maintenance clearance, as well as to assure the feasibility of pipe routing through tight spaces.
- F. Plumbing Riser Diagrams: Plumbing riser diagrams shall be provided for multi-story buildings whenever the relative configuration of piping components cannot be depicted in the plan view alone without ambiguity. As a minimum, riser diagrams shall be provided in the Plumbing Working Drawings for the following systems: all drain waste & vent systems including lab waste, all hot water systems with circulation, all pure water systems, and any other system which includes forced circulation by pumping.
- G. Plumbing Details: Plumbing details shall be provided as necessary to contractually assure a given level of quality. As a minimum, details shall be provided to cover all pipe penetrations of roofs, equipment supports, piping supports on roofs, backflow preventers, equipment installations where the relative position of plumbing appurtenances such as valves, unions, thermometer, drains, etc. are important to function, ease of service, and future replacement, pipe crossings of building expansion joints, pressure reducing assemblies, backflow prevention assemblies, roof drainage assemblies, floor drain assemblies, all pipe penetrations of exterior walls above and below grade.
- H. Piping Diagrams (Schematics) shall be provided whenever the relative arrangements of plumbing components and equipment cannot be clearly depicted in the plans. As a minimum, piping diagrams shall be provided for in the Plumbing Working Drawings for water heating systems with circulation, pure water systems, and lift stations.

END OF SECTION 22 10 05

SECTION 22 11 00 - FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES DESIGN GUIDELINES

A. GENERAL INFORMATION

1. Cal Poly owns and maintains the underground water distribution system throughout the campus.

B. DESIGN REQUIREMENTS

1. All back-flow preventers will be tested by a certified tester prior to the system being put in service immediately after installation.
2. Provide a domestic water pressure reducing valve and meter at each new building.
3. Provide a separate water meter and RP backflow preventer for irrigation at each new building.
4. Fire water should not be metered or reduced in pressure.
5. DCDA assemblies are required by Cal Poly and the County of San Luis Obispo.
6. For new buildings to be connected to the campus water system, the anticipated additional water demand should be identified early during preliminary planning. This water demand should be submitted to the Building Inspector and the Mechanical Engineer for Cal Poly Facilities Planning and Capital Projects.
7. Improvements to the campus system may be required to accommodate the additional demand. The Principal Engineer shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new building.

C. DESIGN CONDITIONS:

1. Water System Pressure: The water pressure assumed for system pipe sizing and design shall be the lower of the following:
 - a. 75 PSI
 - b. The actual system pressure.

- D. Since the water pressure in the campus water mains varies throughout the campus depending on elevation within four water pressure zones, the Plumbing Designer should request the water pressure from the University's Representative for each project. The University's Representative will provide the known pressure at a given point (usually a fire hydrant). The Plumbing Designer will be responsible for determining the pressure at the point of use and should take into account the change in elevation between the known reference point and the point of use.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 11 00

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. ACCEPTABLE PIPING MATERIALS

1. Above Grade: Type L hard drawn copper tubing with wrought copper sweat fittings, 95/5 tin antimony solder for joining 2" and smaller pipe. 15% silver brazing conforming to AWS classification BCuP-5 for joining 2-1/2" and larger piping. Viega ProPress is acceptable up to 4" pipe.
2. Below Grade: Type K hard drawn or soft copper tubing, with wrought copper sweat fittings, all connections brazed with 15% silver brazing conforming to AWS classification BCuP-5, wrap pipe with 1 layer of 10 mil tape. Soft copper tubing with radius bends shall be used to minimize below grade fittings. (Note: Pipe layouts which place water piping under the building slab should be avoided whenever other alternatives are feasible.) Viega Pro Press is acceptable up to 4".

B. WATER PRESSURE REDUCING VALVES

1. Provide a pressure reducing valve (PRV) which will limit the supply pressure to 80 PSI at the domestic water entry point to each building. This PRV shall be provided on water services with pressure below 80 PSI as well as above in order to provide additional protection in the event of a loss of pressure control in the campus water mains.
2. For low system pressures where a PRV may cause an undesirable pressure loss an exception to this requirement may be granted upon obtaining approval from the University's Representative.
3. Provide compound PRV's where required to accommodate a large range of flows.
4. Fire water should not be reduced in pressure. Separate fire water from domestic water ahead of the PRV.

C. VALVING

1. Water piping systems shall be provided with manual isolation valves at the following locations:
 - a. At branch connections to underground system mains.
 - b. At all building points of entry.
 - c. On both sides of piped in devices which may need to be removed for servicing including water meters, back flow preventers, pressure reducing valves, strainers, pumps, etc. The devices shall be removable without draining down the building system.

- d. Exception: On small branch lines (1 inch and less) where the quantity of building water is small, the valve on the downstream side of the device may be omitted.
- e. At each floor where branch piping connects to a riser.
- f. At every restroom and every lab.

D. DOMESTIC / INDUSTRIAL HOT WATER

- 1. For water conservation, all systems shall be designed to provide near immediate hot water at fixtures by using either a hot water circulation pump or electric heat tape. An exception to this is small systems with a short distance (50 feet or less) between the water heater and the fixture. Verify with the University Representative whether heat tape or circulation will be used on a project by project basis.
- 2. For systems with a hot water circulation, verify that the pump is not over selected and that the pipe velocities due to circulation will be reasonably low. (Copper fitting failure due to high velocity scouring has been a problem). Grundfos Alpha Series Pumps are preferred.
- 3. Provide separate heating sources for domestic hot water and space heating water except for buildings served by the campus central heating water system.
- 4. Water heaters shall be installed in a sheet metal drain pan (smitty pan) with drain outlet piped to a safe location on the building exterior or floor drain.
 - a. Exception: Water heaters installed on a concrete floor slab where leakage would not damage the floor or building. Provide a floor area drain in the vicinity of the water heater.
- 5. All hot water piping shall be insulated.
- 6. Water systems shall be designed to prevent water hammer. Provide properly sized shock arrestors adjacent to all quickly closing valves including toilet flush valves, washing machines, dish washers, and solenoid valves. Provide a ball valve below each shock arrestor to allow for removal without system drain down. Provide access doors for all shock arrestors in concealed locations. Shock arrestor locations and sizes should be positively identified within the contract documents.

E. DISINFECTION

- 1. All potable water systems shall be disinfected and analyzed for bacteriological content. No fire system shall be installed into the Campus Domestic loop without back flow prevention.
- 2. Bacteriological analysis shall be completed by a third-party laboratory approved by the Cal Poly Office of Environmental Health & Safety (EH&S). The laboratory shall be submitted via the University Representative for approval by EH&S a minimum of 72-hours prior to conducting disinfection. Analysis results shall be submitted via the University Representative to EH&S to certify compliance with the specifications. Disinfection procedure shall be repeated should EH&S indicate

that compliance with the applicable regulations has not been achieved.
Plumbing shop representative shall be given a copy of the results before the system can be put in service.

3. Provide an industrial water system for non-potable uses at all wet laboratories, faucets with serrated tip for hose connections, dark rooms, and all other locations using toxic or hazardous materials and requiring water service for uses other than drinking. Backflow protection shall be by a reduced pressure principal type back flow preventer.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 11 16

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SECTION 22 11 18 - WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section covers interior domestic cold water, domestic hot water, domestic hot water return, laboratory cold water, laboratory hot water, laboratory hot water return, tempered water, non- potable cold water and trap filler lines to a point 5 ft outside building wall.
- B. All components shall comply with NSF-61 and NSF-372 to be compliant with requirement for lead content of ?0.25% maximum weighted average.

1.2 RELATED WORK

- A. Section 20 00 00 - General Mechanical Requirements
- B. Section 20 05 13 - Motors
- C. Section 20 05 14 - Variable Frequency Drive (VFD) Systems
- D. Section 20 05 29 - Piping and Equipment Supporting Devices
- E. Section 20 05 53 - Mechanical Systems Identification
- F. Section 20 05 73 - Mechanical Systems Firestopping
- G. Section 20 07 00 - Mechanical Systems Insulation
- H. Section 22 05 94 - Domestic Water Systems Balance
- I. Section 22 21 14 - Plumbing Specialties
- J. Section 26 29 13 - Enclosed Controllers

1.3 QUALITY ASSURANCE

- A. Order pipe with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

- B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.
- E. Before shipping, piping shall be cleaned, free of rust and scale, and chemically treated to protect inside of pipe from rusting, and furnished with end caps.

1.5 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Pipe
 - 2. Fittings
 - 3. Joints
 - 4. Valves
 - 5. Unions and Flanges
 - 6. Dielectric fittings
 - 7. Water hammer arrestors
 - 8. Expansion joints
 - 9. In-line Centrifugal Pumps
- B. Shop Drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials as specified shall be new unless otherwise noted.

- B. Materials shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.

2.2 PIPE, FITTINGS, AND JOINTS

- A. Pipe, fittings, and joints for Water Main in Section 22 11 14 - Exterior Services to 5 ft from outside building wall.
- B. Underground 2-1/2" and Smaller:
 - 1. Copper:
 - a. Pipe: Copper tube, Type K, soft (annealed) temper in coils, ASTM B88
 - b. Fittings:
 - 1) Cast copper alloy, solder joint, pressure rated, ANSI B16.18
 - 2) Wrought copper, solder joint, pressure rated, ANSI b16.22
 - 3) Viega Pro Press
 - c. Joints: Where joints are permitted, brazed, silver solder, BCuP-5 Type, AWS.A5.8, 1250°F melting point minimum.
 - d. Pre-insulated with polyurethane insulation and PVC jacket.
 - C. Above Ground:
 - 1. Copper (2-1/2" and Smaller):
 - a. Pipe: Copper tube, Type L, hard drawn, ASTM B88
 - b. Fittings: Viega Pro Press
 - c. Wrought copper, solder joint, pressure rated, ANSI B16.22
 - d. Joints:
 - 1) Lead free (<0.2%) solder, ASTM B32, flux, ASTM B813 Nipples: Red brass pipe, threaded
 - e. Viega ProPress is an acceptable fitting / material.
 - f. Exposed tubing and fittings in kitchen and areas subject to chemical cleaning shall have chrome plated finish.
 - 2. Viega ProPress is an acceptable fitting / material for up to 4".

2.3 UNIONS AND FLANGES

- A. General:
 - 1. Unions, flanges and gasket materials to have pressure rating of not less than 150 psig at 180°F.
- B. Copper (3" and Smaller):
 - 1. Wrought copper union, Nibco Figure 633-W. Mueller Brass or equal.
 - 2. Viega ProPress is acceptable.

2.4 VALVES

A. Shutoff Valves:

1. Ball Valves (2" and smaller):
 - a. Acceptable manufacturers: Nibco, Apollo, Hammond, Milwaukee, Stockham and Watts with indicated features and equal to model listed. Note that not all manufacturers make all sizes. Jomar is an acceptable manufacturer for stainless steel and bronze.
 - b. Full Port, 2 Piece: Lead Free, Stainless Steel or Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Lockable, NIBCO T/S/PC-585-66-LF.
 - c. Full Port, 3 Piece: Lead Free, Bronze body, ASTM B584, stainless steel ball and stem, teflon seats, stem extension with length according to installed system insulation thickness, 600 psi CWP pressure rating, Lockable, NIBCO T/S-595-Y-66-LF.
 - d. Insulated Handle: For insulated systems to prevent condensation on valve body with thermal and vapor seal, equal to NIBCO Nib Seal.
2. Gate Valves:
 - a. Acceptable Manufacturers: Nibco, Apollo, Crane, Hammond, Kennedy, Milwaukee and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes.
 - b. Size 2-1/2" and Smaller: Lead-free bronze body, bronze trim, 300 psi CWP, union bonnet, rising stem, NIBCO T/S/PC-111-LF.
 - c. Size 3" and Larger: Iron bodied with epoxy coating and resilient wedge. Mueller, NIBCO, or approved equal.

B. Swing Check Valves:

1. Size 2" and Smaller:
 - a. Lead Free Bronze body, ASTM B584, Y pattern, PTFE resilient disc, horizontal swing, 200 psi CWP rating, Apollo 163S-LF series
2. Valves 2-1/2" and Larger:
 - a. Nickle iron body, horizontal swing, stainless steel or nickel iron disc, stainless steel replaceable seat, 200 psi CWP rating, NIBCO T/S/PC-413-Y-L.

C. Spring Check Valves:

1. Valves 2" and Smaller:
 - a. Lead Free Bronze body, ASTM B584, in-line lift type with spring, PTFE disc, 250 psi CWP rating, NIBCO T/S-480-Y-LF.
2. Valves 2-1/2" and Larger:
 - a. Cast iron body, wafer type, Buna-N seat, aluminum bronze disc, in-line type with stainless steel spring, 250 psi CWP rating, Nibco W-910-W-LF

- b. Ductile iron body, aluminum bronze or elastomer encapsulated ductile iron disc, stainless steel spring and shaft, welded-in nickel or EPDM synthetic rubber seat, vertical or horizontal installation, grooved ends, 300 psi CWP rating, Victaulic Series 716.
- D. Balancing Valves:
- 1. Circuit Setter:
 - a. Acceptable Manufacturers: Bell and Gossett, Watts, Circuit Solver or equal
 - b. 2" and Smaller: Shall be of lead-free bronze construction with glass and carbon-filled TFE seat rings and have differential pressure read-out ports across valve seat area. Read-out ports to be filled with internal EPT insert and better connection with check valve. Valve bodies to have 1/4" NPT tapped drain/purge port. Valves to have memory stop feature and calibrated nameplate to assure specific valve setting. Valve to be leak-tight at full-rated working pressure and temperature (300 psi/250°F), B&G Circuit Setter Model CB, or approved equal.
 - c. Shall be regulated thermostatically
- E. Mixing Valves
- 1. Thermostatic Master Mixing Valve
 - a. Acceptable manufacturers: Lawler, Watts Powers Intellestation or equal
 - b. Master thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint at zero demand and peak flow with recirculated flow for temperature maintenance. Valve assembly shall be capable of sensing temperature in recirculated water temperature and returning water to main distribution if temperature is adequate or diverting partial flow to heater when temperature falls below setpoint.
 - c. Mixing valve shall be bronze construction with dual thermostatic elements, integral thermometer, check valves, strainer, visual flow indicator and integral thermostatic return limiter. Valve shall be rated for 150 psig operating pressure and be certified under ASSE 1017.
 - d. Valve shall have 140°F hot water inlet, 60°F cold water inlet and 120°F mixed water temperature. Power IntelliStation LFIS200TV or equal.
 - 2. Thermostatic Point of Use Tempered Water mixing Valve
 - a. Acceptable manufacturers: Lawler, Powers or approved equal
 - b. Master emergency fixture thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint. Valve shall fail to cold water supply only on loss of hot water supply. Valve shall fail closed on loss of cold-water supply.
 - c. Mixing valve shall be bronze construction with dual thermostatic elements, high temperature limit stop, locked temperature regulator and integral thermometers on inlet, outlet and mixed water lines. Valve shall be rated

for 125 psig operating pressure and be certified per ANSI Z358.1 requirements.

2.5 WATER METERS

- A. Compound Flow Meter
 - 1. Acceptable Manufacturers: Metron Farnier Spectrum or equal
 - 2. Meter shall be in-line compound meter type consisting of one positive displacement chamber and one turbine chamber. Meter shall have integral or remote converter with graphic display and keypad. Meter shall be factory sized and programmed for its specific application and flow range. Meter shall be reprogrammable using converter keypad without use of special interface device or computer.
 - 3. Meter body shall be lead-free bronze construction with stainless steel trim. Meter shall have thermoplastic piston, turbine chamber and turbine. Meter materials and finish shall meet AWWA Standard C700.
 - 4. Meter shall be provided with ANSI Class 150 flanges.
 - 5. Meter shall be selected for 10:1 turndown. Meter shall be wet-calibrated and accurate to within $\pm 1.5\%$ of reading. Meter shall be shipped with certification of calibration.
 - 6. Meter shall have 4-20 mA and programmable pulse output signals.
 - 7. Meter shall have integral lead-free bronze or stainless-steel plate type strainer. Strainer shall have access cover for cleaning of strainer grid.
 - 8. Meter shall provide instantaneous and totalized flow in gpm and gallon.
 - 9. Basis of Design is Sensus Metering System. Refer to schedules on drawings.

2.6 DIELECTRIC FITTINGS

- A. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation or Victaulic Style 47.
- B. Dielectric unions 2" and smaller; dielectric flanges 2-1/2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F. Watts Regulator Company, Lochinvar, Wilkins Epco Sales, Inc or equal.
- C. Copper-silicon casting, UNS C87850, threaded or grooved end. UL classified in accordance with NSF-61 for potable water service. Victaulic Style 647.

2.7 WATER HAMMER ARRESTORS

- A. Mechanical Water Hammer Arrestors:
 - 1. Piston-compressed air column type, with sealed air chamber.

2. Manufacturers: Watts, Sioux-Chief, and Precision Plumbing Products (PPP), Inc., or equal to size shown. Provide access panels when mechanical shockstops are installed in non-accessible concealed locations.

2.8 EXPANSION JOINTS/LOOPS

A. Galvanized steel pipe, Schedule 40, with mechanical couplings, Victaulic 150 Mover

B. Copper Tubing:

1. Use expansion loops where space is available. Size expansion loops as listed in the following table:

<u>Pipe Size</u>	<u>Length of Each Loop</u>	<u>Number of Legs</u>
3/4"	38"	3
1"	40"	3
1-1/4"	42"	3
1-1/2"	46"	3
2"	50"	3
2-1/2"	54"	3
3"	60"	3
4"	68"	3

C. Copper Tubing:

1. Mechanical expansion fittings, size 3/4" thru 4", copper tube, stainless steel laminated internal bellows, 200 psi working pressure, 600°F rated; Keflex Model 7QT. Mechanical expansion fittings, sizes 3/4" thru 4", copper tube, stainless steel laminated internal bellows, 175 psig working pressure, 500°F rated, Hyspan Model 8509 or 8510.
2. Allowable length of copper tube per mechanical expansion fitting shall be in accordance with the following table:

<u>System Operating Temperature</u>	<u>Length of Pipe</u>
110°F	300 ft
120°F	275 ft
130°F	250 ft
140°F	225 ft
150°F	175 ft
160°F	175 ft
170°F	150 ft
180°F	140 ft

D. Pre-manufactured expansion loop will be allowed: Metraflex Model MLS Series for sweat ends, MLT Series for threaded ends and MLF Series for flanged or groove ends. Verify pipe size required, laying length, and face-to-face dimension required. Coordinate location with other trades.

2.9 IN-LINE CENTRIFUGAL PUMPS FOR TEMPERATURE MAINTENANCE OF POTABLE AND LABORATORY HOT WATER

- A. Manufacturers: Armstrong, Aurora, Bell and Gossett, Deming, Ingersoll-Rand, Taco, Weinman, Worthington or equal
- B. Pumps shall be pipeline mounted, single suction type with cast iron casing, bronze fitted with working pressure of 125 psi and operating temperature of 200°F continuous.
- C. Impellers shall be plastic and shall be directly hung from motor shafts without using flexible couplings.
- D. Pump shafts shall be ceramic, steel or stainless steel, sealed and gasketed from pumped fluid.
- E. Pumps shall be furnished with mechanical carbon/silicon carbide seals.
- F. Bearing assemblies and motor shall be permanently oil lubricated and maintenance free.
- G. Pump shall be controlled by adjustable programmable time clock similar to Bell and Gossett TC- 1 timer kit and aquastat located in return pipe at pump with 100°F to 240°F operating temperature with 5°F to 30°F adjustable differential, remote bulb, UL listed similar to Honeywell L6006A1012.
- H. Refer to Section 26 29 13 - Enclosed Controllers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.
- B. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.
- C. Include connections to plumbing fixtures, to equipment by others, and to equipment requiring water. Provide proper backflow and back siphonage protection to safeguard potable water system from contamination.
- D. Lay out water system so as to conform to intent of drawings. Coordinate piping with building features and work of other trades. Install water piping plumb and square with

building. Plans indicate, general routing, provide additional offsets as required. Install piping with necessary swing joints and offsets to allow for expansion.

- E. Install shut-off valves on branch lines near mains to avoid long dead-leg branches when valves are closed.
- F. Install shut-off valves where indicated and at base of risers to allow isolation of portions of system for repair.
- G. Do not install water piping within exterior walls.
- H. Provide drain valves at base of risers and at low points of trapped piping 2" and larger where trapped water volume exceeds 5 gallons.
- I. Install pressure reducing valves where indicated on drawings. Provide pressure gauges on both inlet and outlet sides of valve. Flush strainer and adjust to outlet pressure as scheduled.
- J. Provide protective sleeve covering of elastomeric pipe insulation where copper or steel piping is embedded in masonry or concrete.
- K. Provide dielectric fittings between dissimilar piping materials.
- L. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.
- M. Install valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to equipment, fixtures and systems installed by others where same requires piping services indicated in this Section.
- N. In-line pumps 3 hp and larger shall be independently supported from building structure.
- O. Install water pipe using proper pipe and fittings. Use reducing fittings for changes in pipe size.
- P. Install trap filler lines to slope to drain tailpiece without trapping.

3.2 UNDERGROUND WARNING TAPE

- A. Provide warning tape for exterior buried utilities per Section 20 05 53.

3.3 COPPER TUBING

- A. Copper tubing shall be installed per Copper Development Association guidelines in addition to methods specified herein.
- B. Soldered Copper Joints:
 - 1. Use non-acidic and lead-free flux on cleaned pipe and fittings for soldered joints.
 - 2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 - 3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
 - 4. Apply heat carefully to prevent damage to pipe, fittings and valves.
 - 5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.
- C. Brazed Copper Joints:
 - 1. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 - 2. Joints shall be cleaned and polished before brazing.
 - 3. Flux of any type shall not be used.
 - 4. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
- D. Pressed Fittings:
 - 1. Viega ProPress is an acceptable fitting / material up to 4"
 - 2. Cut tube square, remove burrs from exterior of tube and ream interior of tube before assembly.
 - 3. Prepare joints properly before pressing.

3.4 SPRING LOADED CHECK VALVES

- A. Provide spring loaded check valve in each pump discharge line.

3.5 WATER METERS

- A. Provide minimum of 10 pipe diameters of straight pipe on inlet of meter and minimum of 5 pipe diameters of straight pipe on outlet of meter.
- B. Provide strainer on inlet to meter.

3.6 WATER HAMMER ARRESTORS

- A. Use water hammer arrestors to control water hammer. Installed devices shall be sized and located according to manufacturer's recommendations, PDI Standards, or as shown on drawings.
- B. Use water hammer arrestors with flush valves and quick-closing valves. Provide access panels when water hammer arrestors are installed in non-accessible concealed locations.

3.7 DIELECTRIC UNIONS AND FLANGES

- A. Install dielectric unions or flanges at points where copper-to-steel pipe connection is required in domestic water systems.
- B. Install unions on equipment side of shutoff valves for items such as: water heaters, water softeners, pumps, filters, and similar equipment requiring periodic replacement.

3.8 EXPANSION JOINTS

- A. Install one anchor on either side of expansion joint, opposite direction of expansion.
- B. Install pipe guides on each side of mechanical expansion fittings.

3.9 CLEANING

- A. Flush and clean piping prior to testing. Remove corrosion by mechanical or chemical means. Use chemicals that are non-toxic.

3.10 TESTING

- A. Refer to Testing paragraph of Section 20 00 00 - General Mechanical Requirements.
- B. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 100 psi for 2 h. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.
- C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.
- D. Do not conceal pipe until satisfactorily tested.
- E. Testing with air will not be allowed.

3.11 BALANCING

- A. Balance water distribution system. Adjust control valves for proper operation. Set balancing valves to maintain hot water in hot water system.
- B. Balance flush valves, flow control valves and mixing valves for adequate flow and temperature to plumbing fixtures and equipment.

3.12 DISINFECTION

- A. Disinfect water piping in the following manner:
 1. Clean and flush water pipe with water until water at remote tap is clear.
 2. Fill water systems with solution containing 50 ppm of chlorine (minimum concentration). Allow solution to stay in water system for 24 h. Alternately use solution of 200 ppm of chlorine (minimum concentration) for 3 h.
 3. Flush water system of chlorine solution.
 4. Allow clean water to stand in system for 24 h. Take sample from remote tap for bacteriological test.
- B. Do not use water system for potable water supply until safe bacteriological test is obtained. Repeat steps 1 through 4 until safe water system is obtained.

3.13 BACTERIOLOGICAL TESTS

- A. Take representative water samples and test to ensure bacteriologically safe water supply system. Include HPC (Heterotrophic Plate Count) test and test for presence of *Pseudomonas aeruginosa* as well as regular coliform bacteria test. HPC test maximum containment level of 500 organisms/ml. Perform bacteriological tests shortly before Owner's acceptance of building. If tests fail, make corrections and retest.
- B. When connecting to existing water supply of unknown quality, sample for analysis and comparison with finished water system analysis shall be taken prior to making new connection. This will allow isolating source of contamination from within scope of work or pre-existing water supply. Final conditions shall meet criteria specified above for areas within scope of work.

END OF SECTION 22 11 18

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL (NOT APPLICABLE)

PART 2 - PRODUCTS

2.1 BALANCING VALVES

- A. Recirculating Domestic Hot Water Balancing Valves:
1. Balancing valves regulate and control the return of hot water to the water heater in a recirculating domestic hot water piping system to ensure that specified hot water temperatures are delivered to all point-of-use fixtures within specified time frames.
 2. Manually Adjusted Balancing Valves: globe valve, needle valve, or venturi valve design with ports for reading temperature and pressure, knob adjustment with graduated set-point markings, and lockable memory setting. A ball valve design is not acceptable. A fixed GPM orifice flow regulation devices are not acceptable as they are not adjustable without disassembly and replacement of a different size orifice to change flow rate.
 3. Automatically Self-adjusting Balancing Valves: mechanical thermostatically controlled valves that automatically self-adjust return water flow to maintain specified temperatures in the DHW circuits.
 4. Electronic DHW balancing systems with remote temperature sensor(s) monitoring DHW circuit temperature(s) and controlling recirculating water flow with automated valves.
 5. Material Construction: all metallic component parts shall be stainless steel or lead-free brass, lead free bronze, or copper. NPT threaded inlet and outlet for use with union connections. Balancing valve rated to 200 psi, 240°F (115°C).
 6. Size: Same line size as their connected piping, but not larger than NPS 2".
 7. Certified in compliance with NSF-61 Annex G, NSF-372 lead free.
 8. Provide line size isolation valves and unions for ease of removal and service. Refer to piping detail shown on drawings. DHW balancing valves, their unions, isolation valves, and Y strainers (if used) shall be made accessible for service, and shall be identified with permanent metallic tags or signage.
 9. Balanced System Testing, Adjustment, and Reporting: all recirculating domestic hot water circuits must provide specified hot water temperatures being delivered to point of use fixtures within specified time frames, and within specified acceptable variable tolerances, and in compliance with Commissioning Plumbing Section 22 08 00.

- a. Manually Adjusted balancing valves must be individually tested and adjusted to balance DHW return flow rates to ensure specified water temperatures are being delivered to the fixtures. DHW balancing report shall include documented temperature readings and valve adjustment settings for each numbered DHW balancing valve, noting their numbered DHW circuits, DHW heater output temperature, test equipment used, testing and adjustment dates and the name of the testing mechanic.
 - b. Automatically Self-adjusting systems can be checked by documented sampling of each recirculating circuits temperatures with a hand-held infrared sensor (IR sensor), or temperature readings taken at point-of-use fixtures within each DHW recirculating circuit. The DHW balancing report shall include documented sample temperature readings by numbered DHW circuits, noting balancing valves or the fixtures sampled by location, DHW heater output temperature, test equipment used, testing dates and the name of the testing mechanic.
10. Automatically Self-adjusting Thermostatic Valve Manufacturers: Subject to compliance with specified requirements, provide DHW balancing valves by one of the following:
- a. ThermoOmegaTech Inc, Circuit Solver #CSUAS series DHW lead-free thermostatic balancing valve
 - b. Armstrong #DRV40 digital recirculation system
 - c. Caleffi lead-free #116 Series Thermosetter balancing valve, provide Y strainer, and isolation valves
11. Manually Adjusted Valve Manufacturers: Subject to compliance with specified requirements, provide DHW balancing valves by one of the following:
- a. Red & White lead-free #9529AB DHW balancing valve, provide Y strainer, and isolation valves
 - b. Griswold, K-Valve-No-Lead Series DHW balancing valves, provide Y strainer, and isolation valves
 - c. Nibco Inc, #T-1710 series lead-free DHW balancing valves, provide Y strainer, and isolation valves.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 11 19

SECTION 22 13 14 - SANITARY WASTE AND STORM DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes materials and methods for sanitary waste and vent, clearwater waste and vent, storm drainage, and overflow storm drainage piping systems within and including piping to 5 ft outside building wall.

1.2 RELATED WORK

- A. Section 20 05 13 - Motors
- B. Section 20 05 20 - Excavation and Backfill
- C. Section 20 05 29 - Piping and Equipment Supporting Devices
- D. Section 20 05 49 - Seismic Anchorage and Restraints
- E. Section 20 07 00 - Mechanical Systems Insulation
- F. Section 22 11 14 - Exterior Services
- G. Section 22 21 14 - Plumbing Specialties
- H. Section 22 40 00 - Plumbing Fixtures

1.3 GENERAL DESIGN INFORMATION

- A. Cal Poly owns and maintains the sanitary sewer system throughout the campus.
- B. For new buildings to be connected to the sanitary sewer system, the anticipated additional sewer load should be identified early during preliminary planning. This load should be submitted to the Building Inspector and the Mechanical Engineer for Cal Poly Facilities Planning and Construction. Improvements to the campus system may be required to accommodate the additional load. The Principal Engineer shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new building.
- C. Systems discharging to the campus sewer system shall be in compliance with the requirements of the City of San Luis Obispo Waste Water Treatment Plant. Mechanical systems discharging unusual wastes may require special provisions or may not be

allowed. Triggers include; high or low pH, oil, grease, chemical contamination, biological contamination, and rain water to the sewer. Mechanical systems typically impacted include: commercial kitchen waste, elevator sump pump discharge, lab process waste, and water purification system waste. The Design Professional shall be responsible for confirming impacts to the project due to the City Waste Water Discharge Ordinance. Alternatives for compliance shall be discussed with the University's Representative. Negotiations involving specific project issues shall be channeled through the Cal Polly Office of Environmental Health & Safety (Director).

- D. For wet laboratories, the method which will be used for dealing with contaminated liquid wastes should be determined early in the design process in consultation with the University's Representative and Cal Poly Environmental Health and Safety (EH&S). Contaminated liquid waste from laboratories are not allowed to be poured directly into drainage systems discharging to the campus sewers. EH&S should be consulted for procedures for dealing with liquid contaminated wastes. Contaminated wastes are typically containerized and held in the laboratory for disposal by EH&S as hazardous waste. Lab waste piping systems are provided in wet laboratories only for disposal of non-hazardous liquids and as a precaution in case of an accidental spill.
- E. Soil and Waste Piping within a building and outside within five feet (5') of the foundation, except where indicated otherwise, shall be No-Hub cast iron pipe and fittings, asphaltum coated, free from defects, and shall conform to the requirements of CISPI Standard 301 ASTM A-888 or ASTM A-74 and manufactured by AB & I, Charlotte or Tyler. Fittings shall be up with Stainless Steel, Heavy-Duty No-Hub Couplings and shall be in compliance with ASTM C-1540 and ASTM C-564 Standards, except all above ground vent piping joints may be made up with Standard-Duty No-Hub Coupling in compliance with CISPI -310, and ASTM C-564 Standards. For fats, oils and grease waste, Blucher Pipe systems are preferred.
- F. Complete soil/waste drainage piping will be provided to each domestic plumbing fixture and will discharge by gravity. Sanitary drainage ventilation piping will be provided to each domestic plumbing fixture or trap and will terminate at various locations on the roof.
- G. Horizontal sanitary, waste and vent piping will be designed for a uniform grade of 2% (1/4" per foot).
- H. HVAC condensate drainage piping (CD) will be provided to each separate HVAC unit, such piping will drain to an indirect waste connection to the sanitary soil/waste system via either tailpiece connection at the nearest lavatory or indirectly to a floor sink.
- I. Floor drains will be provided in laundry rooms and all toilet rooms. Drains will not be located under the partitions and will be provided with clearance for service work.

- J. Underground cast iron pipe will be wrapped with 8 mil polypropylene pipe wrap to protect against low pH soil on campus.
- K. All floor drains will be served by a trap primer. The preferred trap primers will be flush-o-meter valve flushing tube or lavatory p-trap type. (Mechanical type trap primers may be provided only when the preferred type cannot be used.)
- L. Wall clean-outs at the end of runs for main lines should be provided, where possible, above rim height of highest fixture on that line of all floors.
- M. Shower drains will be fitted with removable hair screens within floor drain for ease of maintenance.
- N. Sink drains will be cleanable without disassembly of the associated trap, with cleanout above rim height of sinks on all floors.
- O. Routing drainage piping overhead of electronic equipment, telecom equipment and electrical equipment will be avoided.
- P. Cleanouts will be the same nominal size as the pipe they serve; where they occur in piping eight inches and larger, six inches size will be used. All cleanouts will be accessible.
- Q. Cleanouts will be provided on all floors at the following locations:
 - 1. Horizontal offsets.
 - 2. End of soil, waste, water or storm drains more than five feet in length.
 - 3. Maximum of 50-foot intervals of horizontal runs within the building.
 - 4. Base of vertical sanitary stacks and storm drain leader lines.
 - 5. Each change of direction if the total aggregate change exceeds 90 degrees.
 - 6. Main sewer connection outside of building. A 2-way cleanout with dual access plugs (threaded bronze, thermoplastic, or PVC) will be provided at this location. Cleanout will be installed in round cast iron valve box marked "Sewer".
 - 7. Above rim height of all sinks and lavatories on all floors.
 - 8. Above rim height of all urinals.
 - 9. Up stream of all double santees and combinations.

1.4 ACCEPTABLE PIPING MATERIALS

- A. Above Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, neoprene coupler with stainless steel clamp and shield.
- B. Below Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, extra heavy neoprene coupler with stainless steel clamp and shield (Husky, Clamp All, or equal)

- C. Above Grade Vent Piping (Alternate materials)
 - 1. Schedule 40 galvanized steel pipe with recessed screwed cast iron drainage fittings.
 - 2. Type DWV copper with DWV solder fittings, 50/50 equivalent lead-free solder.
- D. Below grade DWV PVC and CPVC are acceptable above and below grade piping material.
- E. Above / Below Grade Waste and Vent Piping (Alternate material for student housing buildings up to 3 stories only) Schedule 40 PVC, DWV pipe and DWV fittings with solvent cement joints.
- F. Waste vents shall be located a minimum distance of 30 feet horizontally from HVAC air intakes and occupied roof areas. Additionally, waste vents shall be extended with a support system to a level seven feet above the roof when the roof is occupied (such as in the case of roof mounted greenhouses). Waste vents shall not be located in confined roof wells where HVAC air intakes are located.
- G. Provide accessible cleanouts at all levels of the building the same as required by code for first floor and lower levels.
- H. Avoid sewage lift stations where possible. Gravity flow of sewage is preferred and is usually achievable due to the significant elevation change of most building sites on the campus. If a lift station is required, minimize the required capacity by segregating out upper level waste which can be gravity flow. Lift stations should be duplex pump type, powered by emergency power, with alarm contacts provided as an input to the building management system. Lift stations which handle rest rooms sewage shall be grinder type. Provide pumps with rail system option.
- I. Floor drains shall be equipped with trap primers. Trap primer shall be accessible and equipped with a shut off valve to allow for servicing without system drain down.

1.5 QUALITY ASSURANCE

- A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.
- B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to insure material is undamaged and complies with Specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.
- C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.7 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Pipe and fittings
 - 2. Joints
 - 3. Cleanouts
 - 4. Floor drains and floor sinks
 - 5. Roof drains
 - 6. Downspout nozzles
 - 7. Air gap fittings
 - 8. Discharge check valves
 - 9. Discharge isolation valves

PART 2 - GENERAL

2.1 MATERIALS

- A. Materials herein specified shall be new, unless otherwise noted.

2.2 ACCEPTABLE PIPING MATERIALS

- A. Above Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, neoprene coupler with stainless steel clamp and shield.
- B. Below Grade Sanitary Waste and Vent Piping: Service weight, no hub, cast iron soil pipe with cast iron DWV fittings, extra heavy neoprene coupler with stainless steel clamp and shield (Husky, Clamp All, or equal)

- C. Above Grade Vent Piping (Alternate materials)
 - 1. No hub cast iron
 - 2. Type DWV copper with DWV solder fittings, 50/50 equivalent lead-free solder.
- D. Below grade DWV PVC and CPVC are acceptable above and below grade piping material.
- E. Above / Below Grade Waste and Vent Piping (Alternate material for student housing buildings up to 3 stories only) Schedule 40 PVC, h DWV pipe and DWV fittings with solvent cement joints.
- F. Waste vents shall be located a minimum distance of 30 feet horizontally from HVAC air intakes and occupied roof areas. Additionally, waste vents shall be extended with a support system to a level seven feet above the roof when the roof is occupied (such as in the case of roof mounted greenhouses). Waste vents shall not be located in confined roof wells where HVAC air intakes are located.
- G. Provide accessible cleanouts at all levels of the building the same as required by code for first floor and lower levels.
- H. Avoid sewage lift stations where possible. Gravity flow of sewage is preferred and is usually achievable due to the significant elevation change of most building sites on the campus. If a lift station is required, minimize the required capacity by segregating out upper level waste which can be gravity flow. Lift stations should be duplex pump type, powered by emergency power, with alarm contacts provided as an input to the building management system. Lift stations which handle rest rooms sewage shall be grinder type.
- I. Floor drains shall be equipped with trap primers. Trap primer shall be accessible and equipped with a shut off valve to allow for servicing without system drain down.

2.3 PIPE, FITTINGS, AND JOINTS

- A. Interior Underground 15" and Smaller:
 - 1. Schedule 40 polyvinyl chloride pipe (PVC), ASTM D1784, with solvent cement joints:
 - a. Manufacturers: Charlotte, Spears or equal
 - b. No hub cast iron
- B. Interior Above Ground:
 - 1. Schedule 40 chlorinated polyvinyl chloride lab waste pipe (CPVC), ASTM D1784, with solvent cement joints.
 - a. Provide 3M™ Fire Barrier Plenum Wrap 5A+ for piping above ceiling areas unless the piping material is rated to comply with ASTM E84 / UL 723 to

have a flame spread of less than 25 and smoke developed index of less than 50 for use in plenum ceilings.

- b. Manufacturers: Charlotte, Spears or equal
- c. No hub cast iron

2.4 CLEANOUTS

- A. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to number shown on or indicated by drawings.
- B. Provide recessed, solid brass, cleanout plugs where fittings are used as cleanouts. Provide taper- thread plug with Teflon tape thread wrap.
- C. Floor Cleanouts: Cleanout with cast iron ferrule, adjustable top, nickel-bronze scoriated cover and frame, bronze taper-thread plug, equal to J.R. Smith 4033L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4033L-F-C.
- D. Floor Cleanouts, Unfinished Floors and Areas Outside Building: Cleanout with cast iron ferrule, adjustable round top, scoriated cast iron tractor cover, and bronze taper-thread plug, equal to J.R. Smith 4239L. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4239L-F-C.
- E. Floor Cleanouts, Areas with Heavy Traffic: Cleanout with cast iron ferrule, adjustable housing, heavy-duty ductile iron scoriated top, and brass taper-thread plug, equal to J.R. Smith 4233L-M. Provide flashing flange and clamp where cleanout is installed in elevated slabs, equal to J.R. Smith 4233L-M-F-C
- F. Wall Cleanouts: Cleanout with cast iron counter sunk ferrule, bronze or brass taper-thread plug, secured stainless steel access cover, equal to J.R. Smith 4472T. Wall clean outs to be plumbed 2" or less from face of wall.

2.5 FLOOR DRAINS

- A. JR Smith, Blucher, Mifab, Smith, Wade, Watts or Zurn, equal to number as shown on drawings.
- B. Floor drains shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Floor drains shall have internal seepage collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.
- C. Refer to schedule.

2.6 FLOOR SINKS

- A. JR Smith, Mifab, Smith, Wade, Watts or Zurn, equal to number as shown on drawings.
- B. Floor sink shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Double drainage pattern floor sink shall have anchoring and seepage flanged for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Include trap primer connection where indicated on drawings.
- C. Refer to schedule

2.7 ROOF DRAINS AND OVERFLOW DRAINS

- A. JR Smith, Mifab, Smith, Wade, Watts or Zurn, equal to number as shown on drawings
- B. Roof drains and overflow drains shall have cast iron body with adjustable collar, cast iron flashing ring, gravel stops, 10" diameter cast iron dome strainer, and cast-iron underdeck clamp. J.R. Smith 1010Y-RC-CID.
- C. Expansion joints shall be cast iron joint with bronze pipe sleeve and neoprene gasket. J.R. Smith 1710.

2.8 AIR GAP FITTINGS

- A. Air gap fittings constructed of cast iron with integral air gap having free area of at least twice the inlet area. Josam, Mifab, Smith, Wade, Watts or Zurn, equal to J.R. Smith 3950 or 3951.

2.9 DOWNSPOUT NOZZLES

- A. Acceptable Manufacturers: Josam, Smith, Wade or Zurn equal to number listed
- B. Downspout nozzles shall be polished bronze body, wall flange and threaded inlet, equal to J.R. Smith #1770-PB.

2.10 TRAPS

- A. Same material as pipe or fittings unless specified with fixtures. Refer to Section 22 40 00 - Plumbing Fixtures. Provide 17 ga brass, chrome plated traps for exposed traps.

2.11 COOLING COIL CONDENSATE DRAIN/CLEARWATER WASTE

- A. Piping shall be one of the following, unless otherwise indicated on drawings:
 - 1. Copper

- a. Pipe: ASTM B88, Type L, hard temper copper tubing
- b. Fittings: ASTM B16.22 wrought copper fittings
- c. Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite, Viega Pro Press

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations and recognized industry practices.
- B. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.
- C. Grade horizontal lines with minimum of 1/8" per ft, except piping 2" diameter or smaller which shall be run at 1/4" per ft slope.
- D. Grade horizontal lines with minimum of 1/4" per ft, except piping 4" diameter or larger which may be run at 1/8" per ft slope with approval of local authority.
- E. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except, as may be shown on plans. Install overhead piping as high as possible.
- F. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Vent terminations shall be set true and level. Locate vent piping at least 10 ft away from window, door or intake openings. Coordinate closely with roofing contractor to prevent damage to roofing membrane. Flashing shall be in accordance with requirements of roofing manufacturer.
- G. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
- H. Provide protective sleeve covering of elastomeric pipe insulation, where piping and/or fittings are embedded in masonry or concrete.
- I. Maintain piping in clean condition internally during construction.

- J. Mitered ells, notched tees, and orange-peel reducers are not allowed. Bushings are not allowed on threaded piping.
- K. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including required service space for this equipment, unless piping is serving this equipment.
- L. Set cleanouts true and level and protect properly throughout construction.
- M. Set floor drains true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Provide safing for floor drains installed in elevated slabs.
- N. Trap each fixture and piece of equipment requiring sanitary drainage connections. Trap seals shall be standard depth, except when deep seals are required by code. Traps shall be set true and level and located within limits of code requirements. Traps shall not be used as separator, interceptor or other type of device to retain solids. Traps shall be provided with thread type approved cleanout plugs when specified. Protect traps during construction and seal off to prevent stones, debris and other foreign matter from entering before use. Locate running traps for full accessibility with double cleanout.
- O. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

3.2 UNDERGROUND WARNING TAPE

- A. Provide warning tape for exterior buried sewers per Section 20 05 53.

3.3 CAST IRON PIPE

- A. No-hub Piping: Place gasket on end of one pipe or fitting and clamp assembly on end of other pipe or fitting. Firmly seat pipe or fittings ends against integrally molded shoulder inside neoprene gasket. Slide clamp assembly into position over gasket. Tighten fasteners to manufacturer's recommended torque.
- B. Install cast iron pipe and fittings as recommended by CISPI in their publication "Installation of Cast Iron Soil Pipe and Fittings".
- C. Support piping at every coupling. Locate hanger within 18" of coupling.
- D. Installations with multiple joints within a 4 ft developed length shall be supported at every second joint.

- E. Secure base of risers with thrust restraints to prevent joint separation. Restraint shall be in accordance with CISPI recommendations.
- F. Brace horizontal piping 5" and larger to prevent horizontal movement. Install bracing at every branch connection and every change of direction in accordance with CISPI recommendations.

3.4 TESTING

- A. Refer to Testing paragraph of Section 20 00 00 - General Mechanical Requirements.
- B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at highest point. Provide separate standpipe above highest point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 30 minutes before inspection starts.
- C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.
- D. Do not backfill pipe until successfully tested.
- E. Testing with air will not be allowed.

3.5 COOLING COIL CONDENSATE DRAIN/CLEARWATER WASTE

- A. Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.
- B. Pitch pipe down at 1/4" per one foot for proper drainage.
- C. Where copper piping is allowed, joints and fittings may be secured with 95-5 tin-antimony solder or brazing alloys.

END OF SECTION 22 13 14

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SECTION 22 16 00 - NATURAL GAS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies natural gas piping and accessories to 5 ft outside building wall.

1.2 RELATED WORK

- A. Section 20 05 20 - Excavation and Backfill
- B. Section 20 05 29 - Piping and Equipment Supporting Devices
- C. Section 20 05 53 - Mechanical Systems Identification
- D. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.
- B. Installed material not meeting specification requirements must be replaced with material that meets these Specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Promptly inspect shipments to insure material is undamaged and complies with specifications.
- B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.
- C. Off-site storage agreements will not relieve Contractor from using proper storage techniques.
- D. Storage and protection methods must allow inspection to verify products.

1.5 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Pipe and fittings
 - 2. Joints
 - 3. Valves
 - 4. Valve boxes
 - 5. Seismic Shutoff Valves
 - 6. Regulators
 - 7. Appliance connectors

- B. Shop Drawings on items specified herein.

1.6 NATURAL GAS SERVICE

- A. Refer to gas meter schedule on drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials herein specified shall be new, unless otherwise noted.

2.2 BELOW GROUND PIPE, FITTINGS AND JOINTS

- A. 2" and Smaller:
 - 1. Pipe: Thermoplastic polyethylene tubing, PE 2406 or PE3408, ASTM D3350, SDR-11, rated for 80 psig working pressure at 73°F, ASTM D2513
 - 2. Fittings: ASTM D2683, socket fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have socket joint on polyethylene tubing side and plain beveled end on steel side.
 - 3. Joints: Socket fusion or butt fusion
 - 4. Trace Wire: No. 12, copper 600 V, THHN insulation

- B. 2-1/2" and Larger:
 - 1. Pipe: Thermoplastic polyethylene tubing, PE 2406 or PE3408, ASTM D3350, SDR-11, rated for 80 psig working pressure at 73°F, ASTM D2513
 - 2. Fittings: ASTM D3261, butt fusion. Use transition fitting at joints between polyethylene tubing and steel with protective coating. Transition fittings shall have butt joint on polyethylene tubing side and plain beveled end on steel side.
 - 3. Joints: Socket fusion or butt fusion
 - 4. Trace Wire: No. 12, copper 600 V, THHN insulation

- C. Polyethylene (PE) Ball Valves:
 - 1. Complying with 49 CFR Part 192, ASTM D2513, ASTM F2897, and ASME B16.40
 - 2. Manufacturers: Broen, Kerotest or approved equal

- D. Service Entrance Pipe:
 - 1. Same as above ground covered with flexible polymer film with coal tar and synthetic elastomeric coating of 36 mil thickness or extruded high-density polyethylene factory applied coating of 30 mil thickness. Wrap fittings with 10 mil polyethylene tape, ANSI A21.5, double layer, half-lapped. Minimum dielectric strength exceeding 12 kV. Use compatible primer below polymer film or polyethylene tape.

2.3 ABOVE GROUND PIPE, FITTINGS AND JOINTS (UNDER 5 PSIG)

- A. 4" and Smaller:
 - 1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
 - 2. Fittings: ASTM A197/ANSI B16.3 Class 150, black malleable iron, threaded
 - 3. Joints: Threaded
 - 4. Viega MegaPress is an acceptable fitting / material.

2.4 ABOVE GROUND PIPE, FITTINGS AND JOINTS (OVER 5 PSIG)

- A. 2" and Smaller:
 - 1. Pipe: ASTM A53, Grade A or B, Type E, or ASTM A106, Grade B, standard weight, (Schedule 40), carbon steel
 - 2. Fittings: ASTM A105/ANSI B16.11, 3000 lb forged steel, socket weld
 - 3. Joints: Welded
 - 4. Viega MegaPress is an acceptable fitting / material.h

- B. 2-1/2" and Larger:
 - 1. Pipe: ASTM A53, Grade B, Type E or S, standard weight, (Schedule 40), carbon steel
 - 2. Fittings: ASTM A234 Grade WPB/ANSI B16.9, standard weight, (Schedule 40), seamless, carbon steel, welded
 - 3. Joints: Welded
 - 4. Viega MegaPress is an acceptable fitting / material.

2.5 UNIONS

- A. Steel Pipe, 2" and Smaller:
 - 1. Malleable iron, ground brass seat, 150 psi steam working pressure; Stockham Figure 694 or equivalent

2. Forged steel, spiral wound gasket seats, ASTM A105, ANSI B16.5

2.6 FLANGES

- A. Steel Pipe, 2-1/2" and Larger:
 1. ANSI 150 lb class forged steel flanges, ASTM A105/ANSI B16.5. Standard bolt pattern, ANSI 150 lb class 1/8" thick gasket, Type 304 stainless steel, spiral wound metal with graphite filler.

2.7 VALVES

- A. Ball Valves:
 1. Acceptable Manufacturers: Nibco, Neles-Jamesbury, Apollo, Kerotest, and Watts equal to manufacturer's Figure number listed
 2. 2" and Smaller:
 - a. Bronze body, threaded, quarter turn, chrome plated brass ball, large port, reinforced TFE seat and stem packing, blowout-proof stem, 250 psig LP-Gas, UL Listed, CSA certified. NIBCO T-585-70-UL.
 - b. Carbon steel body, threaded, quarter turn, 2 piece design, 316 stainless steel ball and stem, full port, spiral wound 316 stainless steel and teflon seats and seals, blowout proof stem, 800 psi CWP rated, lever handle, CSA certified. Jamesbury Fire-Tite, Series 2000 Style 23-22
 - c. Carbon steel body, quarter turn, 3 piece design, chrome plated steel ball, full port, TFE seats and seals, blowout proof stem, 1000 psi CWP, lever handle, CSA certified. Jamesbury Fire-Tite, Series 4000.
 3. 2-1/2" through 8":
 - a. Carbon steel body, ASTM A216-WCB Class 150, quarter turn, carbon steel flanged ends, Type 316 stainless steel ball, stainless steel stem, PTFE seats and seals, API-6D test requirement. Apollo 88A-140-35-59-TD
- B. Vented Gas Pressure Regulators:
 1. Acceptable Manufacturers: Fisher, Rockwell, Sensus, or American meeting capacity and performance as scheduled
 2. 2" and Smaller Venting: Cast iron body, aluminum spring case, plated steel spring, Nitrile diaphragm and disc, threaded, vent to exterior of building, 150 psi CWP, -20°F to 160°F, listed in compliance with ANSI Z21.80, Fisher S200 series, CS200 series or CS400 series.

2.8 VALVE BOXES

- A. Acceptable Manufacturers: Acorn, Acudor, or equal

- B. Valve Box: Acudor ARVB, recessed wall mounted, 12" by 12" by 4" size, 16 ga stainless steel construction, continuous concealed piano hinge, lever latch or slide latch, #4 satin polish finish, holes for piping penetration
- C. Valves: Ball valves as specified above, with lever handles, easily operated without tools.
- D. Identification: Engraved plastic plate, "NATURAL GAS SHUTOFF VALVE". Refer to Section 20 05 53.

2.9 SEISMIC GAS SHUTOFF VALVE

- A. Valve shall have manual reset, selected with minimum pressure drop based on 7" WC, positive closure, soft seal seating, visual open-close indicator and UL Certified.
- B. Valve shall close within 5 seconds when subjected to horizontal, sinusoidal oscillation at peak acceleration of 0.3 G for period of 0.4 seconds.
- C. Valve shall not close when subjected for 5 seconds to each of the listed horizontal, sinusoidal oscillations as follows:

Peak Acceleration	Period
0.4 G	0.1 seconds
0.08 G	0.4 seconds
0.08 FG	1.0 seconds

- D. Valve shall be either threaded or flanged selected at maximum capacity with minimal pressure drop.
- E. Manufacturers:
 - 1. Koso/California Valves, Tremble Tech Inc., Safe-T-Quake or equal
 - 2. The following are options available only on Koso/California Valves:
 - a. Maximum pressure: 0.5 psi, 7 psi, 20 psi, and 60 psi
 - b. Flanged ends: 2", 3", 4", and 6"
 - c. Three-way valve (seismic shut-off for pneumatic controls. Dry air or Nitrogen ONLY)
 - d. Electrical switch (seismic shut-off for electrical circuits)
 - e. Remote actuator (use with panic switch, smoke/fire alarm)

2.10 METERS

- A. Refer to drawing.

2.11 APPLIANCE CONNECTORS

- A. Appliance connectors shall be corrugated stainless steel tubing with protective exterior coating, brass valve with non-displaceable rotor, brass outlet fitting, and CSA certified. Connector length shall be as required to allow servicing of appliance. Inside diameter of connector shall be 3/8" for appliances up to 60,500 btu/h, 1/2" for appliances up to 106,000 btu/h. Connectors shall be Brass- Craft CSSD44 Series or CSSC44 Series.

2.12 CASEWORK FLEXIBLE GAS PIPING

- A. 2" and Smaller:
1. Tubing: Flexible gas piping shall be UL Listed, FM approved, 300 series corrugated stainless steel tubing (CSST) fabricated in accordance with ASTM A240 and conforming to ANSI/CSA LC-1. Tubing shall be suitable for operation with natural gas or LP (propane) gas.
 2. Fittings and Joints: Yellow brass mechanical fittings and joints with stainless steel AutoFlare pilot insert for ID tubing
 3. Jacket: Fire retarded, UV resistant, extruded polyethylene with ASTM E-84 flame and smoke density rating of 25/50
- B. Manufacturer: OmegaFlex TracPipe or equal

2.13 CATHODIC PROTECTION

- A. Provide complete galvanic anode type cathodic protection system for underground steel gas piping, including devices to electrically isolate system being protected.
- B. Corrosion protection system shall be provided by Contractor regularly engaged in installation and testing of cathodic protection systems. Contractor's personnel shall be experienced and shall be supervised by Engineer who is accredited as Corrosion Specialist by National Association of Corrosion Engineers. Calculations, design and testing shall be performed by Corrosion Specialist. Procedures shall conform to NACE Standards.
- C. Submit catalog cuts and shop drawings for the following:
1. Anodes
 2. Permanent Reference Cells
 3. Cable and wire
 4. Test stations
 5. Terminal boxes
 6. Isolating flanges, unions, coatings, easing seals
 7. Exothermic welding devices
 8. Layout drawings, wiring diagrams

9. Test instruments
 10. Dielectric tape
 11. Test connection points
 12. Accreditation of Corrosion Specialists by National Association of Corrosion Engineers
 13. Calculations from field survey, performed by Corrosion Specialist
- D. Foreign Metallic Contacts:
1. No foreign metal shall be allowed to contact electrically isolated sections of pipe between flange insulators. Where pipe passes through building walls, manholes, valve pits, etc., caution shall be exercised to ensure that pipe does not contact reinforcing steel. Pipe anchors and supports shall not be permitted in contact with metallic structures. Flange insulators shall be placed as close as possible to building and manhole entrances to avoid shorting to other metallic members.
 2. Upon completion of installation, system shall be tested to ensure system performance. One- year service agreement shall be included in base price. Cathodic protection system must be certified by NACE Accredited Corrosion Specialist.
- E. Field Quality Control:
1. Provide system with calculated design life exceeding 40 yrs.
 2. Corrosion Specialist shall perform soil resistivity survey. Survey shall include entire length of proposed right-of-way. Soil survey shall include soil pH and presence of chlorides. Stray current investigation shall also be conducted prior to cathodic protection design.
 3. Corrosion Specialist shall provide engineering calculations to verify design of system. Calculations shall follow format published by recognized corrosion expert.
 4. Corrosion Specialist shall inspect work at least twice to ascertain that there is no grounding, short circuits, coating damage, and that installation is in accordance with standards and methods specified herein.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install gas piping according to requirements of this Section, local gas utility, NFPA 54 National Fuel Gas Code, AGA pamphlets and as shown on drawings.
- B. Piping through roof to be run through approved roof penetration with flashing and counter flashing.

- C. Install buried/underground polyethylene gas piping with trace wire taped to pipe along its entire route. Secure wire to pipe to prevent movement during backfilling. Extend trace wire to valve boxes and service entrance.
- D. Transition from polyethylene piping to steel piping shall occur below grade. Provide cathodic protection and corrosion protection pipe wrap for underground steel pipe.
- E. Install underground polyethylene gas piping exterior to building according to pipe manufacturer's recommendations and to meet local gas utility company's installation standards.
- F. Manufacturer's representative shall instruct workmen in proper techniques for installation of underground polyethylene gas piping and provide certification to Owner's Representative that instructions have been given and proficiency been demonstrated by Contractor for installation of that piping system. Joints must be made by "Qualified" personnel proficient in joining methods of ASTM D2513 thermoplastic gas pressure pipe.
- G. Grounding to gas piping is prohibited.
- H. Gas piping shall be installed with dirt legs adjacent to equipment and with drain tees and plugs at low points.
- I. Gas piping in plenum ceilings shall have welded joints.
- J. Install gas piping above ground in buildings. Gas piping shall not be installed below building floor or footings.
- K. Pitch horizontal piping downward at 1" per 60 ft in direction of flow toward risers or appliances. Install minimum of 4" deep dirt leg at bottom of each vertical run and at each appliance. When installing mains and branches, cap gastight each tee or pipe end, which will not be immediately extended. Take branch connections to main from top or side of main.
- L. Coat underground piping with corrosion resistant tape equal to Tapecoat H-30 and cathodically protected as specified herein. Repair breaks in tape coating caused by installation process.
- M. Make threaded joints by cutting pipe square and reaming inside. Threads shall be cut so exposed threads do not exceed 3 in number. Protect exposed threads against corrosion. Use only joint compounds approved for gas piping.
- N. Seismic shut-off valve must be installed upright, level, plumb, and downstream of regulator or main gas meter (prior to structure it protects). Valve must be rigidly

mounted to earth foundation or structure so that seismic movements will be transmitted to acceleration trigger mechanism within valve assembly.

- O. Do not exceed maximum torque (inch-pounds) specified by valve Manufacturer during installation of seismic shut-off valve.
- P. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

3.2 UNDERGROUND WARNING TAPE

- A. Provide warning tape for exterior buried gas lines per Section 20 05 53.

3.3 PRESSURE REGULATORS

- A. Install regulators in accordance with manufacturer's instructions.
- B. Regulator shall be accessible for maintenance and protected from fire and mechanical damage. Regulator shall be supported from structure by brackets and supports.
- C. Vent from relief valve shall be routed to outside. Terminate vent with protection screen and return bend. If above ground vent terminates in area subject to snow accumulation, terminate line at least 5 ft above grade. Coordinate vent routing with other trades to point of termination. Size vents in accordance with regulator manufacturer's requirements for regulator flow rate and length of run.
- D. Provide unions on both sides of regulators for removal and maintenance.
- E. Provide gas cock for pressure verification.

3.4 METERS

- A. Verify transmission of signal to Building Automation System

3.5 VALVE BOXES:

- A. Mount bottom of box at 60" above finished floor. Adjust height as required to match wall material pattern.
- B. Orient valve to allow closing the door when valve is both open and closed.
- C. Seal pipe penetrations with silicone caulk.
- D. Mount identification placard onto valve box door.

3.6 CONNECTIONS

- A. Provide appliance connectors at ranges, ovens and other appliances, which require that they be relocated before accessing gas connection. Do not use appliance connectors for water heaters or for other equipment or appliances, which do not require that they be relocated before accessing gas connection.
- B. Install shut off valve at each appliance. Provide valved connection at main for equipment and appliances furnished by others.
- C. Shutoff valves shall be accessible in case of emergency; installed minimum of 5 ft from equipment. Provide shutoff valves at each piece of equipment.

3.7 WELDER QUALIFICATIONS

- A. Welding procedures, welders, and welding operators for building service piping to be in accordance with certified welding procedures of National Certified Pipe Welding Bureau and Section 927.5 of ASME B31.9 Building Services Piping or AWS 10.9 Qualification of Welding Procedures and Welders for Piping and Tubing.
- B. Before metallic welding is performed, submit Welding Procedure Specification together with Procedure Qualification Record as required by Section 927.6 of ASME B31.9 Building Services Piping.
- C. Before polyethylene fusion welding is performed, submit certification that welders to be used on this project have successfully demonstrated proper welding procedures in accordance with Code of Federal Regulations, Title 49, Part 192, Section 19 2. 285.
- D. Before welding is performed, submit Standard Welding Procedure Specification together with Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.
- E. Welded joints shall be made in conformance with latest provision of Code for Pressure Piping, ANSI Standard B31-8 - Gas Transmission and Distribution Systems. Welds to be made by qualified welders experienced in piping work. Welding, piping fabrication, etc. shall be in accordance with ASME Code, State Codes, and Welding Manual of Mechanical Contractors Association of America.
- F. Owner's Representative reserves right to test work of welder employed on Project, at Contractor's/Owner's expense. If work of welder is found to be unsatisfactory, welder shall be prevented from doing further welding on project and defective welds replaced at no additional cost to Owner.

3.8 TESTING

- A. Test above ground steel gas piping with dry compressed air at 50 psi for 2 h. Soap test of each joint shall be done to detect leaks during 2 h period. No loss of pressure allowed during test period. No piping shall be concealed until successfully tested.
- B. Test underground polyethylene gas piping at 50 psi with dry air for 2 h. No loss in pressure allowed. Defective joints shall be cut out, pipe repaired, and retested. No piping may be backfilled until successfully tested.
- C. Types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of ASME Code for Pressure Piping, ANSI/ASME B31.1 - Power Piping. If requirements for non-destructive examination are to be other than that stated above, degree of examination, and basis for rejection shall be matter of prior written agreement between fabricator, or Contractor and purchaser.
- D. Local regulating and governing agencies may require periodic testing of seismic valve's ability to shut-off gas flow during seismic event. Follow procedures specified by local governing agency for test.

3.9 CLEANING

- A. Before actuation of gas system, flush system with dry nitrogen to ensure clean system free of oil and construction debris.

END OF SECTION 22 16 00

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SECTION 22 21 14 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section covers material specialties for piping systems.
- B. All components installed on water systems defined in Section 22 11 18 shall comply with NSF-372 to be compliant with requirement for lead content of <0.25% maximum weighted average.

1.2 RELATED WORK

- A. Section 22 05 94 - Domestic Water Systems Balance
- B. Section 22 11 18 - Water Distribution System
- C. Section 22 13 14 - Sanitary Waste and Storm Drainage Systems

1.3 SUBMITTALS

- A. Manufacturer's technical data for the following:
 - 1. Thermometers
 - 2. Pressure gauges
 - 3. Pressure relief valves
 - 4. Strainers
 - 5. Backflow preventers
 - 6. Flexible connections
 - 7. Air vents
 - 8. Trap primers
 - 9. In-line check valves
 - 10. Flashings
 - 11. Safings
- B. Shop drawings on items specified herein.
- C. Certificates: Submit performance testing certificates for reduced pressure backflow preventers and double check backflow preventers.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials herein specified shall be new unless otherwise noted.

2.2 THERMOMETERS

- A. Manufacturers: Miljoco, Taylor, Trerice, Weksler, Winters and Weiss equal to Trerice number listed
- B. Thermometers shall be 9" die cast aluminum case and frame, double strength glass window, adjustable angle stem, permanently stabilized glass tube with mercury free indicating fluid, readable scale with gradations from 30°F to 240°F. Provide brass extension neck sockets of appropriate length. Trerice Series No. A400 (old catalog number BX91400).

2.3 THERMOMETER SOCKETS AND TEST WELLS

- A. Brass construction with threaded connections suitable for thermometer bulbs and control sensing devices, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. Trerice 5550 Series.

2.4 PRESSURE GAUGES

- A. Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Taylor, Trerice, U.S. Gauge, Weiss, and Winters, equal to Trerice number listed
- B. Pressure gauge shall be 4-1/2" die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge, Trerice Series No. 600.
- C. Gauge accuracy shall meet ASME B40.1 Grade 1A (1% full scale).
- D. Pressure gauges shall be calibrated for the following pressure ranges:
 - 1. Domestic Water: 0 to 160 psi at 2 psi increments
 - 2. Medical Air: 0 to 100 psi at 1 psi increments
 - 3. Oxygen: 0 to 100 psi at 1 psi increments
 - 4. Medical Vacuum: 30" Hg at 0.2" Hg increments
- E. Pressure Snubbers:
 - 1. 1/4" or 1/2" size, matching gauge size, 1000 psig WP. Brass for copper or carbon steel pipe, stainless steel for stainless steel pipe.

2.5 PRESSURE RELIEF VALVE

- A. Manufacturers: Cash-Acme, Consolidated, Kunkle, Lonergan, and Watts
- B. Bronze body, resilient seat/seal, ASME Section VIII, stainless steel spring
- C. Refer to Schedules on drawings for performance requirements.

2.6 STRAINERS

- A. Manufacturers: Conbraco, Hoffman, Keckley, Metraflex, Mueller, Wheatley or equal
- B. Strainers shall be comparable to regulator or control valve specified. Strainers shall be "Y" type for liquid service to 400 lbs WOG at 210°F, with 40 mesh stainless steel screen. Body material shall be compatible with installed piping, stainless steel, or FDA approved, heat fused, epoxy coated interior.

2.7 BACKFLOW PREVENTER

- A. Reduced Pressure Zone Backflow Preventers:
 - 1. Manufacturers: Wilkins
 - 2. 3/4" through 2": Bronze body, resilient check valve seats, shut-off valves, Y-pattern strainer with bronze body and stainless-steel screen, drain line air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511, Wilkins 375XL.
 - 3. 2-1/2" through 10": Cast iron body, bronze trimmed check valves, shut-off valves, drain air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511, Wilkins 375A.

2.8 TRAP PRIMERS

- A. Refer to drawings for schedule.

2.9 IN-LINE CHECK VALVES

- A. Manufacturers: Circle Seal Control, DFT, Inc., Apollo Division - Conbraco Industries or equal,
- B. Bronze or bronze/stainless steel construction with spring loaded check (316 stainless steel spring) and straight through flow. Apollo Ball-Cone model 62-100 Series, or equal.

2.10 FLEXIBLE CONNECTIONS

- A. Bronze, braided flexible hose or neoprene twinsphere connectors by Mason Industries with 150 psi WOG working pressure rating.

- B. Alternate manufacturers are Redflex, Resistoflex and Flexonics or equal.

2.11 FLASHINGS

- A. Elastomer Membrane Roofing:
 - 1. Pipe clamps, Fernco Series 1056 flex coupling with Series 300 stainless steel clamps.
- B. Built-Up Roofing:
 - 1. 4 lb/ft² sheet lead, to 18" beyond drain perimeter.
 - 2. Preformed lead vent collar, 4 lb/ft² sheet lead, to 18" beyond vent perimeter; 18" minimum square base flange.
 - 3. Nobleflex roof drain flashing of Chloraloy and 20 lb/ft² asphalt saturated roofing felt bonded together.

2.12 SAFINGS

- A. 4 lb/ft² sheet lead, to 18" beyond edge of drain on all sides.
- B. Chlorinated polyethylene (CPE) as manufactured by Noble Company under trade name Chloraloy 240.
- C. Polyvinyl Chloride (PVC) shower pan line, 40 mil thickness, ASTM D4551.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide thermometers where indicated on drawings. Thermometers shall be easily read from floor or maintenance platforms. Calibrate thermometers to insure accuracy.
- B. Install pressure gauges where indicated on drawings. Gauges shall be easily read from floor or maintenance platforms. Provide extensions as required to make gauges easily readable. Calibrate gauges to insure accuracy.
- C. Install backflow preventers as indicated on drawings. Flush debris from strainers. Certified tester shall test reduced pressure zone backflow preventers to verify that functions are operational. Route vent line to adjacent hub drain.
- D. Install strainers for equipment including pumps, meters, backflow preventers, reducers and regulators, and as shown on drawings.

- E. Install trap primer units as recommended by manufacturer and as indicated for priming drain traps. Insure positive air gap to protect against backflow. Install in-line trap sealer as recommended by manufacturer.
- F. Install in-line check valves where specified or as indicated on drawings.
- G. Install flexible connections for base mounted pumps and other vibrating equipment.
- H. Install air vents at high points in water systems where air may collect.
- I. Safing:
 - 1. Install safing for floor drains. Extend safing to 18" from edge of drain. Safing shall be clamped to floor drain body and pitched to drain to weep holes. Floor drains installed in unexcavated areas do not require safing.
 - 2. Install safings for showers. Concrete floor shall be smooth and free of dirt. Seal joints per manufacturer's recommendations and turn up sides minimum of 6" above curb or maximum water level. Safing shall clamp into drip pan of floor drain and be secured by flashing clamp to assure drainage into weep holes of drain body. Inside vertical corners of showers shall have 12" strips 6 ft above floor, extend 6" in each direction and bottom to overlap pan 3".
 - 3. Membrane roofing material, preformed elastomer pipe pots, and flashing seams are provided by Roofing Contractor for pipe penetrations and drain flashing. Plumbing Contractor shall provide drain flashing clamps and stainless-steel strap clamps for piping penetrations. Coordinate with General Contractor to facilitate sealing drain flashing and pipe penetrations.
- J. Flashing:
 - 1. Coordinate flashings on roof closely with Roofing Contractor. Install flashings as required to insure proper vapor barrier and as directed by Architect.
 - 2. Install flashing for roof drains and overflow drains. Flashing shall extend minimum of 18" beyond edge of drain and shall be clamped into drain body.
 - 3. Use premolded flashing assembly for roof penetration of medical air intake piping. Install 1" of insulation between flashing and outside of pipe.
 - 4. Use premolded flashing assembly with hood for roof penetrations of medical vacuum exhaust piping. Set bottom of hood at 24" above finished roof.
 - 5. Roof penetrations for corrosive or acid vent systems shall be preformed EPDM vent pot with flex coupling pipe clamp collar.

3.2 TESTING

- A. Safings shall be subject to standing water test to detect leaks and proper drainage to weep holes of floor drain.

END OF SECTION 22 21 14

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General Design Requirements
- B. Water Heaters:
 - 1. Commercial electric.
- C. Domestic water heat exchangers.

1.2 GENERAL DESIGN REQUIREMENTS

- A. Domestic Water System
 - 1. Cold water systems will be sized using CPC flush valve curves, and hot water systems using flush tank curves. Equipment branches and main pipe size will be based on flow requirements without diversity.
 - 2. All plumbing valves will be located behind a lockable access panel when they are in a concealed location.
 - 3. Hose bibs will be provided on the roof of each building. The hose bibs will be spaced 50 ft apart, maximum.
 - 4. Chrome plated stops with gasket seats will be provided for sinks, lavatories, and wash basins when exposed to public view. A hose bibb with vacuum breaker will be provided under the lavatories in each toilet room. Exposed branch water supply piping in toilet rooms and custodial rooms will be chromium plated.
 - 5. Water hammer arrestors will be provided in the wall, as required, behind a lockable access panel. Trap primers from lavatory tailpieces or water closet flush-o-meter valves for floor drains will also be provided.
 - 6. Isolation valves and unions at equipment connections will be provided.
 - 7. The water piping will be designed to provide a minimum residual pressure at the most remote water closet of at least 30 psig. Pressure regulators will be installed to comply with California Plumbing Code.
 - a. The maximum water pipe velocity will be 5 ft/sec. for hot water and 8 ft./sec for cold water.
 - b. The minimum supply pipe size will be 1/2" for one plumbing fixture with a maximum flow of 1.25 gpm.
 - c. Fixture pipe sizes will be as follows: 1-1/2" for a flush valve water closet, 3/4" for a shower, 1/2" for sink and 3/4" for hose bibs.
 - 8. Domestic water piping within the buildings will be "Viega" pro-press or equal copper tubing and shall conform to ASTM B 75 or ASTM B88, Fittings shall be

copper in conformance with ASTM B16.18, ASTM B16.22 or ASTM B16.26. O-rings for copper press fittings shall be EPDM.22 32 00 Domestic Water Filtration Equipment.

- B. Acceptable Piping Materials:
 - 1. Socket fused polypropylene prepared specifically for deionized service. Pipe shall be sterilized and capped immediately after production. Fittings, valves, and unions shall be sterilized and individually wrapped immediately after production. Continuous trough support system.
 - 2. Schedule 80 PVC with solvent weld fittings prepared specifically for deionized service. Pipe shall be sterilized and capped immediately after production. Fittings, valves, and unions shall be sterilized and individually wrapped immediately after production. Continuous trough support system. Stainless steel could be used in some applications.
 - 3. Confirm piping material with the University's representative on a case by case basis.
 - 4. Valves shall be diaphragm type.

1.3 SUBMITTALS

- A. See Division 1 for submittals procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Provide electrical characteristics and connection requirements.
- C. Shop Drawings:
 - 1. Indicate heat exchanger dimensions, size of tappings, and performance data.
- D. Project Record Documents: Record actual locations of components.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Certifications:
 - 1. Water Heaters: NSF approved.
 - 2. Electric Water Heaters: UL listed and labeled to UL 174.
 - 3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 WATER HEATERS

- A. Manufacturers:
 - 1. A.O. Smith Water Products Co: www.hotwater.com
 - 2. Rheem Manufacturing Company: www.rheem.com

- B. Commercial Electric:
 - 1. Type: Factory-assembled and wired, electric, vertical storage.
 - 2. Performance:
 - 3. Electrical Characteristics:
 - 4. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.
 - d. Anode: Magnesium.
 - 5. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq. in. (11.6 W/sq. m.).

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 30 00

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SECTION 22 40 00 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section lists plumbing fixtures and accessories including method of installation.

1.2 RELATED WORK

- A. Section 22 11 18 - Water Distribution System
- B. Section 22 13 14 - Sanitary Waste and Storm Drainage Systems
- C. Section 22 16 00 - Natural Gas Piping

1.3 SUBMITTALS

- A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.
- B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials as specified shall be new unless otherwise noted.
- B. Vitreous china fixtures shall be of highest quality, non-absorbent, hard-burned, and vitrified throughout.
- C. Enameled ware shall be quality cast iron of uniform thickness and density, glazed to uniform depth and high gloss rubbed smooth, without chips or flaws, craze, or cracks, and completely acid resisting.
- D. Stainless steel fixtures shall be 302/304 types of non-corrosive steel, 18 ga self-rim for cabinet sinks, 14 ga for free standing compartment type sinks. Sink material shall have satin finish and coved corners, with faucet holes punched to match specified faucet fitting.

- E. Insulation for traps and supplies shall be molded closed cell vinyl insulation and shall meet ASTM E84 for flame and smoke spread. Insulation shall be vandal resistant and be color as listed.

2.2 MANUFACTURERS

- A. Plumbing fixtures shall be provided from list of approved manufacturers. Home Market, Generic Broker, or Wholesaler's house brands are not acceptable.
- B. Water closets, urinals, and lavatories: American Standard, Zurn, Duravit, or Kohler equal to number listed
- C. Water Closet Seats: Church, Bemis, Beneke, Centoco, Olsonite, or Zurn equal to number listed
- D. Flush Valves: Zurn or Sloan equal to number listed
- E. Stainless Steel Sinks: Elkay or Just equal to number listed
- F. Electric Water Coolers: Elkay , Halsey-Taylor , Haws , Oasis , or Sunroc equal to model listed
- G. Mop Basins (Janitor Sinks): American Standard , Fiat , Mustee , Stern-Williams , or Zurn equal to number listed
- H. Manual Faucets: Kohler, Moen Commercial, Chicago Faucet, Zurn or equal to number listed
- I. Sensor Activated Faucets: Moen Commercial, Bradley, or Zurn equal to model listed
- J. Fixture Traps: Engineered Brass Company , Kohler , McGuire , or Zurn equal to number listed
- K. Insulated Traps and Supplies: McGuire , ProFlo, or True-Bro equal to model listed
- L. Supplies and Stops: Chicago Faucet , Kohler , McGuire or Zurn equal to number listed
- M. Supplies and Stops: Brasscraft , Engineered Brass Company , Kohler , LSP Aqua-Flo or McGuire equal to number listed
- N. Shower Valves and Mixing Valves: Symmons, Zurn, or equal to number listed

2.3 CARRIERS AND SUPPORTS

- A. Carrier manufacturers shall be Josam , J.R. Smith , Wade , or Zurn , as outlined herein, with models suitable to fixture and use intended. Provide carriers with adjustable faceplate, rectangular steel uprights and at least 3 bolt lugs for securing carrier to floor. Adjustable water closet carriers shall be either right or left, single or double, horizontal or vertical as suggested by drawings and riser diagrams.

2.4 REFER TO SCHEDULE ON DRAWINGS FOR DETAILED FIXTURE SELECTION CRITERIA

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install plumbing fixtures as recommended by manufacturer. Caulk around fixtures mounted on irregular surfaces such as tile or stone with silicone sealant, same color as fixture.
- B. Support fixtures with proper carrier for each use. Insure that carrier is solidly anchored to prevent rocking whatever piping is used. Anchor bolts in carrier foot shall extend 3" minimum into concrete slab.
- C. Fixture carriers shall be suitable for securing each plumbing fixture in place solidly, yet allowing its removal when necessary. Carriers shall be capable of mounting "Barrier Free" fixtures at suitable heights.
- D. Install each fixture with trap easily removable for servicing and cleaning. Install fixture stops in readily accessible location for servicing.
- E. Install barrier free fixtures in compliance with local code and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above finished floor to avoid contact by wheelchair users.
- F. Return fixture waste and supply piping into wall as high as practical under fixture. Provide accessible shutoff in fixture supply. Protect "barrier free" supply and drain piping with white colored wrap neatly trimmed to prevent contact with hot or sharp surfaces by user.
- G. Coordinate with Electrical Contractor for electronic sensor wiring necessary to install "sensor" operated fixtures. Provide "shockstops" at supplies to solenoid activated fixtures.

- H. Provide individual supplies to fixtures and rough-in fixture piping with adequate support to prevent movement fore, aft and laterally. Provide additional blocking as required.
- I. Install flush valves for barrier-free water closets with operator handle facing wide side of toilet stall.
- J. Provide unions at water connections to drinking fountains and electric water coolers.

3.2 PROTECTION

- A. Protect finished surfaces of fixtures from accidental damage or discoloration by use of protective covering.

3.3 CLEANING

- A. Prior to Owner acceptance, clean fixtures with compounds recommended by manufacturer and remove stains and marks from surrounding walls and countertops.

END OF SECTION 22 40 00

SECTION 22 47 00 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Electric water coolers.
- B. Drinking fountains/Hydration Stations.

1.2 RELATED REQUIREMENTS

- A. Section 22 05 00 - Common Work Results for Plumbing
- B. Section 22 10 05 - Plumbing Piping.
- C. Section 22 11 16 - Domestic Water Piping
- D. Section 22 13 00 - Facility Sanitary Sewerage
- E. Section 22 30 00 - Plumbing Equipment.
- F. Section 22 40 00 - Plumbing Fixtures

1.3 SUBMITTALS

- A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 DRINKING FOUNTAINS AND WATER COOLERS

- A. Water Cooler: Electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air-cooled condenser and stainless-steel grille.

1. Capacity: 8 gallons per hour (30.3 liters per hour) of 50 degrees F (10 degrees C) water with inlet at 80 degrees F (27 degrees C) and room temperature of 90 degrees F (32 degrees C), when tested in accordance with ASHRAE Std 18.
 2. Electrical: 115 V, 60 Hertz compressor, 6 foot (2 m) cord and plug for connection to electric wiring system including grounding connector.
- B. Hydration Station:
1. Elkay Model LZWSSM Surface Mount or Haws 1212SF bottle filling station. Sanitary, touchless activation with auto 20-second shut-off.
 - a. WaterSentry Plus 3000-gallon capacity filtration system, certified to NSF/ANSI 42 & 53 (Lead, Class 1 Particulate, Chlorine, Taste 7 Odor)
 - b. Integrated silver ion anti-microbial protection
 - c. Fill rate: 1.5 gpm; 1.1 gpm when connected to a remote chiller
 - d. Laminar flow to reduce splash
 - e. Real drain system
 - f. Visual user interface display includes:
 - g. Green Ticker counts bottles saved from waste
 - h. LED visual filter monitor indicates when to replace filter
 - i. Optional remote chiller can be installed within 15 feet of unit to deliver chilled drinking water.

2.3 EMERGENCY EYE AND FACE WASH

- A. Emergency Wash: ANSI Z358.1; wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy control valve and fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components level and plumb.

END OF SECTION 22 47 00

SECTION 23 00 00 - HEATING VENTILATING AND AIR CONDITIONING (HVAC)

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS, UNIVERSITY GUIDELINES AND STANDARDS

A. Code Rules and Safety Orders:

1. Construction as called out on working drawings shall be in full accordance with the rules and regulations of all ten parts of the California Code of Regulations, Title 24 (The California Building Standards Code) per University administrative policy. Title 24 includes amended versions of the Uniform Building Code, Uniform Mechanical Code, Uniform Plumbing Code, National Electric Code and the Uniform Fire Code. Also included is the California Energy Code (Title 24, Part 6).

B. Additional government codes and regulations shall be complied with as applicable to the project.

1. The regional air quality management district with jurisdiction over the Cal Poly Campus is the San Luis Obispo County Air Pollution Control District ((805) 7815912) with headquarters in San Luis Obispo, California. Mechanical systems regulated by the district include: fume exhaust systems, cooling towers, fuel burning equipment (depending on size & fuel type), paint spray booths, incinerators, and dust handling equipment. A "Permit to Construct" must be obtained from the District prior to beginning construction or modification on any system regulated by the District. The Design Professional shall be responsible for identifying project impacts requiring compliance with Air Pollution Control District regulations Alternatives for compliance shall be discussed with the Cal Poly Project Manager. The Design Professional shall provide Cal Poly with all information required to obtain a "Permit to Construct". Permit applications, and related correspondence shall be channeled through the Cal Poly Environmental Health & Safety Office (Environmental Programs Manager).
2. Systems discharging to the campus sewer system shall be in compliance with the requirements of the City of San Luis Obispo Waste Water Treatment Plant (Industrial Waste Inspector (805) 781-7215). Mechanical systems discharging unusual wastes may require special provisions or may not be allowed. Triggers include high or low pH, oil, grease, chemical contamination, biological contamination, and rain water to the sewer. Mechanical systems typically impacted include commercial kitchen waste, elevator sump pump discharge, lab process waste, and water purification system waste. The Design Professional shall be responsible for confirming impacts to the project due to the City Waste Water Discharge Ordinance. Alternatives for compliance shall be discussed with the University's Representative. Negotiations involving specific project issues shall be

channeled through the CAL POLY Environmental Health & Safety Office (Director).

1.2 BASIC DESIGN PRIORITIES:

- A. Program Requirements / Design Guidelines / Government Codes: Mechanical systems shall be designed to meet the more stringent of: the user requirements as identified in the Program, the requirements these Design Guidelines, or applicable government codes and regulations. The Design Professional shall be responsible for notifying the University's Representative of conflicting requirements. The University's Representative shall provide the final decision as to how conflicts will be resolved.
- B. Ease of Maintenance / Operation: Mechanical systems shall be designed to be easily maintained and operated. Access and service space shall be key considerations of the design. Equipment requiring the movement of heavy items for service shall be located such that it is assessable by a hand truck from service vehicle parking locations. Equipment requiring frequent monitoring shall be located so as to be easily accessible from service vehicle parking locations.

1.3 EQUIPMENT REPLACEABILITY:

- A. Mechanical equipment shall be located such that replacement is possible without building demolition. Buildings shall be provided with special provisions (oversized doors, removable louvers, access plates, etc.) as required to meet this requirement.

1.4 SYSTEM LIFE:

- A. Mechanical systems shall be designed to last the life of the building. Components shall typically be institutional grade. With approval of the University's Representative, an exception to this requirement may be granted for systems to support specialized applications with a short life expectancy.

1.5 WATER CONSERVATION:

- A. Mechanical system shall be designed to minimize water use. CAL POLY has a longstanding tradition of frugal water use. Design decisions which significantly impact water use shall be brought to the attention of the University's Representative. The University's Representative shall provide the final decision on such matters.

1.6 UTILITY METERING:

- A. All mechanical utilities serving a building shall be metered. This shall include Water, Natural Gas, Campus Heating Hot Water, Campus Chilled Water and Chilled Water (when produced at a plant outside the building). See applicable Sections for metering

specifics. A complex of residential buildings may be master metered with approval of the University's Representative.

1.7 DESIGN DOCUMENTATION:

- A. Design documentation shall be provided for all mechanical systems to assure efficiency in the mechanical design process and to serve as a reference after construction.
- B. Conceptual Design Report / Mechanical Systems: At the Schematic Design phase, submit a "Conceptual Design Report" for the project's mechanical systems, covering each anticipated mechanical system in the project. A key element of the report shall be a discussion of the alternative systems available to meet the identified needs. Design Development work for the mechanical systems shall not begin until the University's Representative has approved a conceptual alternative for each mechanical system.
 - 1. Conceptual Design Report shall include:
 - a. Identification of the mechanical services required in each type of space included in the project.
 - b. The base criteria to be used for capacity sizing each mechanical service to each space type within the project. Identify the source of the criteria (e.g., consultant recommendation, program requirement, building user interview, code requirement, campus standard, equipment manufacturer). State extent to which services will be oversized to accommodate future growth.
 - c. A discussion of the pro and cons of the design alternatives available for each mechanical system.
 - d. A recommended alternative for each mechanical system.
 - e. Space allocation required for each recommended alternative.
 - f. A description of access to be provided to each major piece of mechanical equipment.
- C. Design Development Report / Mechanical Systems:
 - 1. The Design Development submittal shall include a "Design Development Report" covering each mechanical system in the project. This report shall include:
 - a. Room by room documentation of required mechanical services.
 - b. A written description of each mechanical system covering system purpose, system type, utility inputs, and locations of all major equipment.
 - c. The criteria to be used in sizing and laying out each mechanical system and the source of the criteria (similar to Conceptual Design Report).
 - d. Rough schematics of the proposed systems indicating major equipment, points of connection to existing utilities, and the rooms served by each mechanical utility.
 - e. A description of the required space to accommodate each major element of the proposed mechanical systems, including mechanical rooms, exterior

- mechanical yards, roof mounted mechanical equipment, mechanical shafts, and ceiling space provisions.
 - f. A complete description of access for maintenance and replacement to each piece of mechanical equipment.
 - g. Rough equipment sizing calculations.
 - h. Catalog cut sheets on all major mechanical equipment.
 - 2. Title 24 Building Envelope Plan Check Compliance Documents: The Design Professional shall submit Title 24, Part 6; Building Envelope Plan Check Compliance Documentation no later than the 50% Working Drawing Submittal.
 - 3. Title 24 Mechanical Plan Check Compliance Documents: Title 24 The Design Professional shall submit Title 24, Part 6; Mechanical Plan Check Compliance Documentation no later than the 50% Working Drawing Submittal.
 - 4. Final Mechanical Calculations & Equipment Documentation: Final mechanical calculations shall be submitted no later than the 50% Working Drawing Submittal. These calculations shall document the final basis of design for all mechanical equipment and systems. Title 24 plan check documentation may be used to supplement the calculations where applicable. Also included shall be manufacturer's catalog cut sheet and sizing tables on all major mechanical equipment being used as the basis of design.
- D. Working Mechanical Drawings
- 1. Maintenance access space as recommended by the manufacturer shall be indicated on the drawings for all mechanical equipment. Designated access spaces shall include as a minimum: equipment access door swings, control panel access, tube pulls, coil removal space, fan shaft removal space, lubrication point access, and fire box access.
 - 2. No abbreviation or symbol shall be used on the drawings unless included in the legend.
 - 3. No work shall be called out in a manner which is not contractually enforceable.
 - 4. Work shall not be called out in a design / build format on drawings intended for competitive bidding unless specifically approved by the University's Representative.
 - 5. Mechanical Equipment shall have all important features specified. (Model number alone shall not be considered sufficient) Specifications for University Projects must be open to more than one bidder per Public Works Contract Law except in very specific situations. The specifications should be written in a manner which encourages competition among vendors of equivalent mechanical equipment yet precludes inferior products. To this end the quality level of all major features should be specified. See Part 1 of the Guidelines for further guidance on the method of calling out equivalent products for University contracts.
 - 6. Natural and Mechanical Ventilation

- a. California Mechanical Code (CMC) requires that naturally ventilated space must also be provided with mechanical ventilation unless the system meets any of the following exceptions:
 - 1) Exception #1: An engineered natural ventilation system where approved by the AHJ need not comply with Section 40 2. 2.
 - 2) Exception #2: A mechanical ventilation system is not required where natural ventilation openings comply with the requirements of Section 402.2 and are permanently open or have controls that prevent the openings from being closed during occupancy.
 - 3) Exception #3: A mechanical ventilation system is not required where the zone is not served by heating or cooling equipment.

- E. Energy Design Goals:
 1. Energy Efficiency: Mechanical system shall be designed to minimize energy use. Cal Poly has a long-standing tradition of frugal energy use. Design decisions which significantly impact energy use or cost shall be brought to the attention of the University's Representative. The University's Representative shall provide the final decision on such matters.
 2. Depending on the project size, the ER is responsible for performing the energy model to demonstrate a project's energy efficiency to meet requirements of Title 24 Part 6 Energy Code, and the CSU Energy Policy.
 3. The following systems may be considered to help reach sustainability goals:
 - a. Solar thermal for domestic hot water
 - b. Photovoltaic panels
 - c. Phase Change Material
 - d. Wall insulation
 - e. Glazing performance
 - f. Sunshades

- F. Mechanical Load Basis of Design
 1. Outdoor Design Conditions
 - a. Summer: 87°F db/65°F WB (ASHRAE 0.5%, San Luis Obispo, CA)
 - b. Winter: 33°F (ASHRAE 0.2%, San Luis Obispo, CA)
 - c. Elevation: 320 ft.
 - d. California Climate Zone: 5
 2. Indoor Design Conditions
 - a. Lecture Halls: heat to 70°F, cool to 76°F
 - b. Lab Space: heat to 70°F, cool to 76°F
 - c. Other spaces: heat to 70°F, cool to 76°F
 - d. Bedroom: Heating only, 70°F +/-2°F
 - e. Living Room: Heating only, 70°F +/-2°F
 - f. Study Room: Heating only, 70°F +/-2°F

- g. Laundry Room: Ventilation and Heating only
 - h. Entry/Lobby (in dorm buildings): Ventilation and Heating only
 - i. Admin Spaces: 75°F cooling, 70°F heating
 - j. Elec. Rooms: Cooling only, 85°F
 - k. Data/telecom rooms: Cooling only, 75°F
 - l. Elevator machine rooms: Cooling only, 85°F
- G. Indoor Humidity Control
- 1. All areas, unless otherwise noted: no humidifiers required.
- H. California Minimum Ventilation Criteria
- 1. All areas: 15 cfm/person or 0.15 cfm/sq.ft. minimum, whichever is greater.
 - 2. Comply with California Building Energy Efficiency Standard.
 - 3. Comply with Chapter 4 of CMC.
- I. Exhaust to Outdoors (Minimum Rates)
- 1. Toilet rooms: 12 air changes per hour or 75 cfm/fixture, whichever is greater.
 - 2. Janitor closet: 100 cfm or 10 air changes per hour, whichever is greater.
 - 3. Shower rooms: 12 air changes per hour
 - 4. Main trash rooms: 12-15 air changes per hour
 - 5. Floor trash closets: 50 to 100 cfm per floor
- J. Ductwork Design Criteria (Maximum Allowable Values)
- 1. Air velocities above these maximum values require acoustical treatment.
 - 2. Supply ducts:
 - a. Exposed in occupied spaces: 0.08" wg/100 ft and 1500 ft/min velocity
 - b. Above ceiling in occupied spaces: 0.08" wg/100 ft and 1800 ft/min velocity
 - c. In shafts adjacent occupied spaces: 0.20" wg/100 ft and 2000 ft/min velocity
 - d. In shafts adjacent unoccupied spaces: 0.30" wg/100 ft and 3000 ft/min velocity.
 - 3. Return/exhaust ducts:
 - a. Exposed in occupied spaces: 0.06" wg/100 ft and 1000 ft/min velocity
 - b. Above ceiling in occupied spaces: 0.06" wg/100 ft and 1500 ft/min velocity
 - c. In shafts: 0.10" wg/100 ft and 2000 ft/min velocity
 - d. In mechanical rooms: 0.20" wg/100 ft and 3000 ft/min velocity
 - 4. General building/toilet exhaust ducts: 0.10" wg/100 ft and 1500 ft/min velocity
- K. Coils
- 1. Maximum face velocity: 450 fpm
 - 2. Maximum fins per inch: 12
 - 3. Maximum air pressure drop - heating coil: 0.25" wc

- L. Equipment Access:
 - 1. Provide clear access to equipment for inspection and maintenance.
 - 2. Access Panels: Provide adequate, unobstructed access to equipment and ceiling access panels.
 - 3. Volume/Balancing Dampers: Locate access panels within 18 inches of service point.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 00 00

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SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

- B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.25.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with

belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

9. Sound Power Levels: Conform to NEMA MG 1.

D. Single Phase Motors:

1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115/230 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 THREE-PHASE MOTORS FURNISHED LOOSE

A. Manufacturers:

1. GE Industrial Motors; Wolong Electric Group Co., Ltd.
2. Marathon Electric Motors.
3. Siemens Industry, Inc., Energy Management Division.
4. WEG.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds indicated.

C. Voltage: 208 volts, three phase, 60 Hz.

D. Service Factor: 1.25.

E. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated.

F. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

G. Insulation System: NEMA Class F.

H. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

I. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.

- J. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- K. Sound Power Levels: Conform to NEMA MG 1.
- L. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.3 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 EXISTING WORK

- A. Disconnect and remove abandoned motors
- B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing motors to remain or are to be reinstalled.

3.2 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors in accordance with motor manufacturer's requirements.
- B. Install engraved plastic nameplates in accordance with Section 26 05 53.
- C. Ground and bond motors in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 23 05 13

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel.
9. Firestopping and accessories for HVAC Work.
10. Equipment bases and supports.

B. Related Requirements:

1. Section 03 10 00 - Concrete Forming and Accessories: Placement of inserts in concrete forms as required by this Section.
2. Section 03 30 00 - Cast-in-Place Concrete: Placement of concrete housekeeping pads as required by this Section.
3. Section 07 84 00 - Firestopping: Firestopping for placement by this Section.
4. Section 07 90 00 - Joint Protection: Sealant materials for placement by this Section.
5. Section 09 90 00 - Painting and Coating: Painting as required by this Section.
6. Section 09 96 35 - Chemical-Resistant Coatings: Painting as required by this Section in designated areas subject to chemical corrosion.
7. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Coordination with installation of rigid pipe anchors.
8. Section 22 07 00 - Plumbing Insulation: Piping and accessory insulation as required by this Section.

1.2 DEFINITIONS

- ##### A. Firestopping (Through-Penetration Protection System):
- The material used to seal or stuff or an assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire-rated construction.

1.3 REFERENCE STANDARDS

- A. American Welding Society:
 - 1. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- B. ASME International:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
 - 3. ASME B31.9 - Building Services Piping.
- C. ASTM International:
 - 1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 2. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
 - 3. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
 - 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- D. FM Global:
 - 1. FM - Approval Guide.
- E. Intertek Testing Services (Warnock Hersey Mark):
 - 1. WH-ETL - Product Directory.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- G. UL:
 - 1. UL - Fire-resistance-rated Systems and Products.
 - 2. UL 263 - Fire Tests of Building Construction and Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

1.4 PREINSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturer's catalog information, including load capacity.
 - 2. Firestopping: Submit information on product characteristics, performance, and limitations.
 - C. Shop Drawings:
 - 1. Indicate system layout with location, including critical dimensions and sizes.
 - 2. Indicate pipe hanger and support locations, and detail of trapeze hangers.
 - D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrated items, and specified design numbers to seal openings to maintain fire-resistance rating of adjacent assembly.
 - E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - F. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load-carrying capacity of trapeze, multiple-pipe, and riser support hangers.
 - 2. Submit sizing methods and calculations sealed by a registered professional engineer (P.E.).
 - 3. Firestopping Engineering Judgments: For conditions not covered by UL or WH-ETL listed designs, submit judgments by licensed P.E. suitable for presentation to authority having jurisdiction for acceptance as meeting fire protection code requirements.
 - G. Manufacturer Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
 - H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
 - I. Qualifications Statements:
 - 1. Submit qualifications for manufacturer, installer, and licensed professional.
 - 2. Submit manufacturer's approval of applicator.
 - 3. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- 1.6 QUALITY ASSURANCE
- A. Through-Penetration Firestopping of Fire-Rated Assemblies:
 - 1. Comply with UL 1479 or ASTM E814.
 - 2. Positive Pressure Differential:

- a. As required to achieve fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
 - b. Minimum 0.10 inch wg (24.9 Pa).
 3. Wall Penetrations: Fire F-ratings as indicated on Drawings, but not less than one hour.
 4. Floor and Roof Penetrations:
 - a. Fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
 - b. Floor Penetrations within Wall Cavities: T-rating not required.
- B. Through-Penetration Firestopping of Non-fire-rated Floor and Roof Assemblies:
 1. Materials: Resist free passage of flame and products of combustion.
 2. Noncombustible Penetrating Items: Connecting maximum three stories.
 3. Penetrating Items: Materials approved by authorities having jurisdiction for connecting maximum two stories.
- C. Fire-Resistive Joints in Fire-Rated Floor, Roof, and Wall Assemblies:
 1. Comply with ASTM E1966 or UL 2079.
 2. As required to achieve fire-resistance rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire-Resistive Joints between Floor Slabs and Exterior Walls:
 1. Comply with ASTM E119.
 2. Positive Pressure Differential:
 - a. As required to achieve fire F-ratings and temperature T-ratings as indicated on Drawings for floor assembly.
 - b. Minimum 0.10 inch wg (24.9 Pa).
- E. Surface-Burning Characteristics:
 1. Maximum 25/450 flame-spread/smoke-developed index.
 2. Testing: Comply with ASTM E84.
- F. Welding of Hanger and Support Attachments to Building Structure: Comply with applicable authority.
- G. Perform Work according to California Building standards.
- H. Maintain one copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
- C. Welders: AWS qualified within previous 12 months for employed weld types.
- D. Licensed Professional: experienced in design of specified Work and licensed at Project location.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

- A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions:
 - 1. Do not apply firestopping materials if temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).
 - 2. Maintain this minimum temperature before, during, and for minimum three days after installation of firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.

1.10 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

- B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. CADDY; nVent.
2. Carpenter & Paterson, Inc.
3. Empire Industries, Inc.
4. Globe Pipe Hanger Products Incorporated.
5. Haydon Corporation.
6. Hilti, Inc.
7. NIBCO INC.
8. PHD Manufacturing, Inc.
9. PHS Industries, Inc.
10. Unitron Product, Inc. / US-Strut.
11. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Refrigerant Piping:

1. Conform to ASME B31.5, ASTM F708, MSS SP-58.
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches (50 mm) and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 Inches (75 mm) and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches (100 mm) and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated carbon-steel ring.

C. Accessories:

1. Hanger Rods: Mild steel threaded both ends.

2.2 INSERTS

A. Manufacturers:

1. CADDY; nVent.

2. Carpenter & Paterson, Inc.
3. National Pipe Hanger Corporation.
4. PHS Industries, Inc.
5. Pipe Shields Inc.
6. Piping Technology & Products, Inc.
7. Rilco Manufacturing Co., Inc.
8. Unitron Product, Inc. / US-Strut.
9. Value Engineered Products, Inc.
10. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:

1. Malleable iron case with steel shell and expander plug for threaded connection.
2. Lateral adjustment, top slot for reinforcing rods, and lugs for attaching to forms.
3. Size: To suit threaded hanger rods.

2.3 FLASHING

A. Metal Flashing:

1. Material: Galvanized steel.
2. Thickness: 26 gage (0.5 mm).

B. Metal Counterflashing:

1. Material: Galvanized steel.
2. Thickness: 22 gage (0.8 mm).

C. Sheet Lead Flashing:

1. Waterproofing: 5 psf (24.5 kg/sq. m).
2. Soundproofing: 1 psf (5 kg/sq. m).

D. Flexible Flashing:

1. Material:
 - a. Sheet butyl.
 - b. Compatible with roofing.
2. Thickness: 47 mils (1.2 mm).

E. Caps:

1. Material: Steel.
2. Minimum Thickness:
 - a. 22 gage (0.8 mm).
 - b. 16 gage (1.5 mm) at fire-resistive elements.

2.4 EQUIPMENT CURBS

A. Manufacturers:

1. Lloyd Industries, Inc.
2. LMCurbs.
3. Metal Form Manufacturing, Inc.
4. Pate Company (The).
5. Roof Products, Inc.
6. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:

1. Shell and Base: Welded 18-gage (1.2-mm-thick) galvanized steel.
2. Cant: Mitered; 3 inches (75 mm).
3. Variable Step: To match root insulation.
4. Insulation Thickness: 1-1/2 inches (38 mm).
5. Wood Nailer: Factory installed.

2.5 SLEEVES

A. Pipes through Non-fire-rated Floors:

1. Material: Galvanized steel.
2. Thickness: 18 gage (1.2 mm).

B. Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gage (1.2-mm-thick) galvanized steel.

C. Round Ductwork: Galvanized steel.

D. Rectangular Ductwork: Galvanized steel or wood.

E. Sealant:

1. As specified in Section 07 90 00 - Joint Protection.
2. Material: Acrylic.

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. GPT; a division of EnPRO Industries.
2. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:

1. Type: Modular mechanical.
2. Configuration: Interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
3. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and insulation.

2.7 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. B-line; Eaton, Electrical Sector.
 - 2. Unistrut; Atkore International.
 - 3. Substitutions: As specified in Section 01 60 00 - Product Requirements.

- B. Description:
 - 1. Material: Galvanized 12-gage (2.8-mm-thick) steel.
 - 2. Thickness: 12 gage (2.8 mm).
 - 3. Hole Spacing: 1-1/2 inches (38 mm) o.c.

2.8 FIRESTOPPING

- A. Firestopping Materials: As specified in Section 07 84 00 - Firestopping.

- B. Manufacturers:
 - 1. 3M Fire Protection Products.
 - 2. A/D Fire Protection Systems Inc.
 - 3. Hilti, Inc.
 - 4. HoldRite; Reliance Worldwide Company.
 - 5. Johns Manville; a Berkshire Hathaway company.
 - 6. Nelson; Emerson Electric Co., Automation Solutions.
 - 7. NUCO Inc.
 - 8. Passive Fire Protection Partners.
 - 9. RectorSeal HVAC; a CSW Industrials Company.
 - 10. Specified Technologies, Inc.
 - 11. Tremco, Inc.
 - 12. Substitutions: As specified in Section 01 60 00 - Product Requirements

- C. Description:
 - 1. Various types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements.
 - 2. Provide only one type for each similar application.
 - 3. Silicone Elastomeric Firestopping: Single-component silicone elastomeric compound and compatible silicone sealant.
 - 4. Foam Firestopping Compounds: Single-component foam compound.
 - 5. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 - 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 - 7. Firestop Pillows: Formed mineral-fiber pillows.

2.9 FIRESTOPPING ACCESSORIES

- A. Installation Accessories: As specified in Section 07 84 00 - Firestopping.
- B. Primer: Type as recommended by firestopping manufacturer for specific substrate surfaces and as suitable for required fire ratings.
- C. Permanent Dam Material:
 - 1. Mineral fiberboard.
 - 2. Mineral fiber matting.
- D. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- E. General:
 - 1. Furnish UL-listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- F. Nonrated Surfaces:
 - 1. Covering for Openings in Occupied Areas Where Piping is Exposed: Stamped-steel, chrome-plated, hinged, split-ring escutcheons, or floor or ceiling plates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that openings are ready to receive sleeves.
- C. Verify that openings are ready to receive firestopping.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that may affect bond of firestopping material.
- C. Remove incompatible materials that may affect bond.
- D. Install backing materials to arrest liquid material leakage.

- E. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- F. Do not drill or cut structural members.
- G. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION

- A. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches (100 mm) and larger.
 - 4. If concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. If inserts are omitted, drill through concrete slab from below and provide through bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- B. Pipe Hangers and Supports:
 - 1. Comply with ASME B31.1, B31.5, B31.9.
 - 2. Support horizontal piping as scheduled.
 - 3. Minimum Hanger Spacing: 1/2 inch (13 mm) between finished covering and adjacent Work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 5. Minimum Vertical Hanger Adjustment: 1-1/2 inches (38 mm).
 - 6. Support vertical piping at every floor.
 - 7. If piping is installed in parallel and at same elevation, provide multiple-pipe or trapeze hangers.
 - 8. Support riser piping independently of connected horizontal piping.
 - 9. Provide copper-plated hangers and supports for copper piping.
 - 10. Design hangers for pipe movement without disengagement of supported pipe.
 - 11. Painting and Coating:
 - a. Prime coat exposed steel hangers and supports as specified in Section 09 90 00 - Painting and Coating.
 - b. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 12. Insulation:
 - a. Provide clearance in hangers and from structure and other equipment for installation of insulation.
 - b. As specified in Section 22 07 00 - Plumbing Insulation.

- C. Equipment Bases and Supports:
 - 1. Provide housekeeping pads of concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.
 - 2. Minimum Size: 3-1/2 inches (87 mm) thick and extending 6 inches (150 mm) beyond supported equipment.
 - 3. Use templates furnished with equipment to install equipment anchor bolts and accessories.
 - 4. Supports:
 - a. Brace and fasten with flanges bolted to structure.
 - 5. Provide rigid anchors for pipes after vibration isolation components are installed as specified in 210548 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.

- D. Flashing:
 - 1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
 - 2. For sound control, provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms.
 - 3. Curbs:
 - a. Provide curbs for roof installations with minimum height of 14 inches (350 mm) above roofing surface.
 - b. Flash and counterflash with sheet metal and seal watertight.
 - c. Attach counterflashing to equipment and lap base flashing on roof curbs.
 - d. Flatten and solder joints.
 - 4. Storm Collars:
 - a. Adjust storm collars tight to pipe with bolts and calk around top edge.
 - b. Install storm collars above roof jacks.
 - c. Screw vertical flange section to face of curb.

- E. Sleeves:
 - 1. Exterior Watertight Entries: Seal with mechanical sleeve seals.
 - 2. Set sleeves in position in forms and provide reinforcing around sleeves.
 - 3. Sizing:
 - a. Size sleeves large enough to allow for movement due to expansion and contraction.
 - b. Provide for continuous insulation wrapping.
 - 4. Extend sleeves through floors 1 inch (25 mm) above finished floor level, and calk sleeves.
 - 5. Spaces:
 - a. If piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing insulation and calk airtight.

- b. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
 - c. Install chrome-plated steel escutcheons at finished surfaces.
- F. Firestopping:
- 1. Firestopping Materials: As specified in Section 07 84 00 - Firestopping.
 - 2. Install material at fire-rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items requiring firestopping.
 - 3. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
 - 4. Apply firestopping material to uniform density and texture and in sufficient thickness to achieve required fire and smoke rating.
 - 5. Placement: Compress fibered material to maximum 40 percent of its uncompressed size.
 - 6. Placement:
 - a. Place foamed material in layers to ensure homogenous density, filling cavities and spaces.
 - b. Place sealant to completely seal junctions with adjacent dissimilar materials.
 - 7. Placement: Place intumescent coating in sufficient coats to achieve required rating.
 - 8. Dam Material: Remove after firestopping material has cured.
 - 9. Fire-Rated Surfaces:
 - a. Seal opening at floor, wall, and roof.
 - b. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
 - c. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
 - d. Pack void with backing material.
 - e. Seal ends of sleeve with UL-listed fire-resistive silicone compound to meet fire rating of structure being penetrated.
 - 10. Nonrated Surfaces:
 - a. Seal opening through non-fire-rated wall, floor, and roof opening.
 - b. Install sleeve through opening and extending beyond minimum of 1 inch (25 mm) on both sides of building element.
 - c. Size sleeve allowing minimum of 1 inch (25 mm) void between sleeve and building element.
 - d. Install type of firestopping material as recommended by manufacturer.
 - 11. Occupied Spaces:
 - a. Install escutcheons where conduit penetrates non-fire-rated surfaces in occupied spaces.

- b. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
- 12. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
- 13. Interior Partitions:
 - a. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.6 PROTECTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.7 ATTACHMENTS

- A. Pipe Hanger Spacing:
 - 1. Pipe Material: Copper tube.
 - a. Size: 1-1/4 inches (32 mm) and smaller.
 - b. Maximum Hanger Spacing: 6 feet (1.8 m).
 - c. Hanger Rod Diameter: 1/2 inch (13 mm).
 - 2. Pipe Material: Copper tube.
 - a. Size: 1-1/2 inches (39 mm) and larger.
 - b. Maximum Hanger Spacing: 10 feet (3.0 m).
 - c. Hanger Rod Diameter: 1/2 inch (13 mm).

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Inertia bases.
2. Vibration isolators.
3. Duct sound attenuators.
4. Ductwork lagging.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this Section and product requirements for concrete for placement by this Section.
2. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this Section.
3. Section 08 91 00 - Louvers: Product requirements for acoustic wall louvers.
4. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product requirements for anchors and piping expansion compensation.
5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
6. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this Section.
7. Section 23 31 00 - HVAC Ducts and Casings: Vibration isolation devices for ducts and casings.
8. Section 23 33 00 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct sound attenuators specified for placement by this Section.

1.2 REFERENCE STANDARDS

A. Air Movement and Control Association International, Inc.:

1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. Air-Conditioning, Heating, and Refrigeration Institute:

1. AHRI 575 - Method of Measuring Machinery Sound within an Equipment Space.

C. American National Standards Institute:

1. ANSI S1.4 - Specification for Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.

3. ANSI S1.13 - Measurement of Sound Pressure Levels in Air.
 4. ANSI S12.60 - Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.
- D. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 68 - Laboratory Method of Testing to Determine the Sound Power in a Duct.
 2. ASHRAE Handbook - HVAC Applications.
- E. ASTM International:
1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 2. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
 3. ASTM E596 - Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures.
- F. Sheet Metal and Air Conditioning Contractors' National Association:
1. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- 1.3 PREINSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.
- 1.4 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
1. Submit schedule of vibration isolator type with location and load on each.
 2. Submit manufacturer catalog information indicating materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- C. Shop Drawings:
1. Indicate static and dynamic load of both inertia bases and vibration isolators.
 2. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for fabricated sound attenuation products.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions indicating that maximum room sound levels are not exceeded.
 - F. Test and Evaluation Reports: Indicate dynamic insertion loss and noise generation values of sound attenuators.
 - G. Manufacturer Instructions:
 - 1. Submit special procedures and setting dimensions.
 - 2. Indicate installation requirements maintaining integrity of sound isolation.
 - H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
 - I. Manufacturer Reports: Certify that sound isolation installation is complete and complies with instructions.
 - J. Qualifications Statements:
 - 1. Submit qualifications for manufacturer, installer, and licensed professional.
 - 2. Submit manufacturer's approval of installer.
- 1.5 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
 - B. Project Record Documents:
 - 1. Record actual locations of hangers including attachment points.
- 1.6 QUALITY ASSURANCE
- A. Perform Work according to AMCA 300 standards and ASHRAE 68 recommendations.
 - B. Maintain one copy of each standard affecting Work of this Section on Site.
- 1.7 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
 - B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
 - C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed at Project location.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for inertia bases.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Provide vibration isolation devices on motor-driven equipment over 0.5 hp (0.35 kW), plus connected piping and ductwork.
- B. Minimum Static Deflection of Isolators:
 - 1. Basement - Under 20 hp (15 kW).
 - a. Under 400 rpm: 2.0 inch.
 - b. 400 to 600 rpm: 1.0 inch (25 mm).
 - c. 600 to 800 rpm: 0.5 inch (12 mm).
 - d. 800 to 900 rpm: 0.2 inch (5 mm).
 - e. 1,100 to 1,500 rpm: 0.15 inch (4 mm).
 - f. Over 1,500 rpm: 0.1 inch (3 mm).
 - 2. Basement - Over 20 hp (15 kW).

- a. Under 400 rpm: 2.0 inch.
 - b. 400 to 600 rpm: 2.0 inches (50 mm).
 - c. 600 to 800 rpm: 1.0 inch (25 mm).
 - d. 800 to 900 rpm: 0.5 inch (12 mm).
 - e. 1,100 to 1,500 rpm: 0.2 inch (5 mm).
 - f. Over 1,500 rpm: 0.15 inch (4 mm).
- C. Consider upper floor locations critical unless otherwise indicated.
- D. Use concrete inertia bases for fans having static pressure greater than 3.5-inch wg (0.85 kPa), motors larger than 40 hp (30 kW), and on base-mounted pumps larger than 10 hp (7.5 kW).
- E. Maintain indicated maximum sound level of spaces by using acoustical devices.
- F. Maintain rooms at following maximum sound levels, according to Noise Criteria (NC) as defined by ASHRAE Handbook - HVAC Applications.
1. Offices:
 - a. Conference Rooms: 30.
 - b. Private: 35.
 - c. Open-Plan Areas: 40.
 - d. Computer/Business Machine Areas: 45.
 - e. Public Circulation: 45.
 2. Schools:
 - a. Comply with ANSI S12.60.
 - b. Lecture Halls and Classrooms: 30.
 - c. Open-Plan Classrooms: 35.
 - d. Teaching Studios: 30.

2.2 INERTIA BASES

- A. Manufacturers:
1. Kinetics Noise Control, Inc.
 2. Vibration Mountings & Controls, Inc.
 3. Vibro-Acoustics.
 4. Substitutions: As specified in Section 01 60 00 - Product Requirements.
- B. Structural Bases:
1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine and to transmit design loads to isolators and snubbers.
 2. Construction: Welded structural steel with gusset brackets, supporting equipment, and motor with motor slide rails.

- C. Concrete Inertia Bases:
 - 1. Minimum Mass: 1.5 times weight of isolated equipment.
 - 2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, and concrete filled.
 - 3. Connecting Point: Reinforced to connect isolators and snubbers to base.
 - 4. Concrete:
 - a. Type: Reinforced.
 - b. Compressive Strength: 3,000 psi (20 MPa).

2.3 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.; a VMC Group Company.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control, Inc.
 - 6. Mason Industries, Inc.
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation.
 - 9. Vibration Mountings & Controls, Inc.
 - 10. Substitutions: As specified in Section 01 60 00 - Product Requirements.
- B. Open Spring Isolators:
 - 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.
 - 2. Springs:
 - a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 - 3. Spring Mounts: Furnish leveling devices, minimum 0.25-inch (6-mm)-thick neoprene sound pads, and zinc chromate-plated hardware.
 - 4. Sound Pads:
 - a. Size: Based on minimum deflection of 0.05 inch (1.2 mm).
 - b. As specified for neoprene pad isolators.
- C. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.
 - 2. Springs:

- a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 3. Spring Mounts: Furnish leveling devices, minimum 0.25-inch (6-mm)-thick neoprene sound pads, and zinc chromate-plated hardware.
 4. Sound Pads:
 - a. Size: Based on minimum deflection of 0.05 inch (1.2 mm).
 5. As specified for neoprene pad isolators.
 6. Restraints: Furnish mounting frame and limit stops.
- D. Closed Spring Isolators:
 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.
 3. Springs:
 - a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 inch (7 mm).
- E. Restrained Closed Spring Isolators:
 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.
 3. Springs:
 - a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 inch (7 mm) and limit stops.
- F. Spring Hangers:
 1. Spring Isolators:
 - a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
 - b. Code: Color-code springs based on load carrying capacity.

2. Springs:
 - a. Minimum Horizontal Stiffness: 75 percent of vertical stiffness.
 - b. Working Deflection: Between 30 and 60 percent of maximum deflection.
 3. Housings: Incorporate neoprene isolation pad as specified for neoprene pad isolators.
 4. Misalignment: Capable of 20-degree hanger rod misalignment.
- G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
 - a. Hardness: 30 durometer.
 - b. Minimum Thickness: 1/2 inch (13 mm).
 - c. Maximum Loading: 40 psi (275 kPa).
 - d. Rib Height: Not greater than 0.7 times width.
 2. Configuration: 1/2-inch (13-mm)-thick waffle pads bonded to each side of 1/4 inch (6 mm)-thick steel plate.
- H. Rubber Mount or Hanger:
1. Material: Molded rubber.
 2. Deflection: 0.5 inches (13 mm).
 3. Insert: Threaded.
- I. Glass-Fiber Pads: Neoprene-jacketed, pre-compressed, molded glass fiber.
- J. Seismic Snubbers:
1. Description: Non-directional and double-acting unit consisting of interlocking steel members restrained by neoprene elements.
 2. Neoprene Elements:
 - a. Replaceable.
 - b. Minimum Thickness: 0.75 inch (18 mm).
 3. Capacity: Four times assigned load to mount groupings at 0.4-inch (10-mm) deflection.
 4. Attachment Points and Fasteners: Capable of withstanding three times rated load capacity of seismic snubber.
- 2.4 DUCT SOUND ATTENUATORS
- A. Manufacturers:
1. Dynasonics.
 2. Kinetics Noise Control, Inc.
 3. McGill AirSilence LLC.
 4. Metal Form Manufacturing, Inc.
 5. Substitutions: As specified in Section 01 60 00 - Product Requirements.

- B. Description:
1. Duct section with sheet metal outer casing, sound-absorbing fill material, and inner casing of perforated sheet metal.
 2. Incorporate interior baffles of similar construction.
 3. Fabrication: According to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Configuration:
1. Rectangular, with lined splitters with radius nose and contoured tails.
 2. Modular.
- D. Materials:
1. Outer Casing:
 - a. Minimum 22-gage (0.8-mm) galvanized steel stiffened with mastic-filled lock-formed seams.
 - b. Slip Joints:
 - 1) Length: 2 inches (50 mm).
 - 2) Thickness: 11 gage (2.9 mm).
 - 3) Location: Both ends.
 2. Inner Casing and Splitters: Minimum 24-gage (0.6-mm) perforated galvanized steel.
 3. Fill:
 - a. Material: Glass fiber or mineral wool.
 - b. Minimum Density: 3 pcf (48 kg/cu. m).
 4. Fill Liner: Bonded glass-fiber matting.
- E. Insertion Losses:
1. Comply with ASTM E477.
- F. Maximum Generated Noise:
1. Comply with ASTM E477.

2.5 DUCTWORK LAGGING

- A. Acoustic Insulation:
1. Material: Glass fiber or mineral wool.
 2. Thickness: 2 inches (50 mm).
 3. Density: 3 to 5 pcf (50 to 80 kg/cu. m).
- B. Covering:
1. Material: Sheet lead.
 2. Minimum Surface Weight: 4 psf (20 kg/sq. m).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that equipment, ductwork, and piping are installed before starting Work of this Section.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

3.3 INSTALLATION

- A. Support duct sound attenuators independent of ductwork, as specified in Section 23 33 00 - Air Duct Accessories.
- B. Lagging:
 - 1. Lag ductwork, where indicated, by wrapping with insulation and covering.
 - 2. Apply covering airtight.
 - 3. Do not attach covering rigidly to ductwork.
- C. Attach ductwork to acoustic louvers with flexible duct connections as specified in Section 23 33 00 - Air Duct Accessories.
- D. Install isolation for motor-driven equipment.
- E. Bases:
 - 1. Steel: Provide 1 inch (25 mm) of clearance between housekeeping pad and base.
 - 2. Concrete Inertia: Provide 2 inches (50 mm) of clearance between housekeeping pad and base.
- F. Make equipment level.
- G. Install spring hangers without binding.
- H. Isolators:
 - 1. Closed Spring Isolators: Adjust such that side stabilizers are clear under normal operating conditions.
 - 2. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary

shims to final height; when full load is applied, adjust isolators to load to allow shim removal.

- I. Provide pairs of horizontal limit springs on fans with more than 6.0 inches (1.5 kPa) of static pressure and on hanger-supported, horizontally mounted axial fans.
- J. Snubbers:
 - 1. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers.
 - 2. Provide each inertia base with minimum of four seismic snubbers located close to isolators.
 - 3. Equipment Designated for Post-Disaster: Snub to 0.05-inch (1.5-mm) maximum clearance.
 - 4. Other Snubbers: Provide clearance between 0.15 and 0.25 inch (4 and 7 mm).
- K. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector.
- L. Support piping connections to isolated equipment resiliently as follows:
 - 1. Up to 4-Inch (100-mm) Diameter: First three points of support.
 - 2. 5- to 8-Inch (125- to 200-mm) Diameter: First four points of support.
 - 3. 10-Inch (250-mm) Diameter and Larger: First six points of support.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Inspect isolated equipment after installation and submit report, including static deflections.
- D. Sound Measurements: As specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- E. Testing Agency:
 - 1. Furnish services of testing agency to take noise measurement.
 - 2. Use meters according to ANSI S1.4.

3.5 ATTACHMENTS

- A. Pipe Isolation Schedule:
 - 1. Isolated Distance from Equipment:

- a. Pipe Size 1 inch (25 mm): 120 pipe diameters.
- b. Pipe Size 2 inches (50 mm): 90 pipe diameters.
- c. Pipe Size 3 inches (75 mm): 80 pipe diameters.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.2 REFERENCE STANDARDS

- A. Current Edition of the California Mechanical Code (CMC)

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

1.4 University Guidelines and Requirements

- A. Volume/Balancing Dampers:
 - 1. Plan Notations: Clearly identify on plans.
 - 2. Field Identification: Provide visible, accessible identification. Example: Brightcolored streamers.

- B. Property ID Labels for Equipment:
- C. Submittals:
 - 1. List of Equipment for Property ID Labels:
 - 2. Submit list of equipment for Property ID Labels, including location, function, equipment manufacturer's name, and model and serial numbers for verification by Engineer.
 - 3. After acceptance by Engineer: Submit hard and electronic copies for assignment of bar-coding identification numbers by Campus Facility Services.
 - 4. Samples: Submit two Property ID Labels.
 - 5. Closeout Submittals: Project Record Documents: Record actual locations of labeled items; include bar-code numbers, and provide as-built electronic copy of list of equipment with location, function, equipment manufacturer's name, and model and serial numbers.
- D. Pre-Installation Meetings:
 - 1. Convene minimum two weeks prior to commencing work of this section.
- E. Labels:
 - 1. Description: Property ID Labels.
 - 2. Material: Anodized Aluminum.
 - 3. Size: 2 x 0.875 inches.
 - 4. Attachment: Adhesive backed.
 - 5. Message:
 - 6. Printed identification:
 - 7. First Line: "[University Name] MEP"
 - 8. Second Line: "Facility Services"
 - 9. Bar code: Code numbers shall be provided by the University Facility Services via the Trustees Representative.

PART 2 - PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Ductwork: Nameplates.

- F. Heat Transfer Equipment: Nameplates.
- G. Instrumentation: Tags.
- H. Major Control Components: Nameplates.
- I. Piping: Tags.
- J. Pumps: Nameplates.
- K. Relays: Tags.
- L. Small-sized Equipment: Tags.
- M. Tanks: Nameplates.
- N. Thermostats: Nameplates.
- O. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- P. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Manufacturers:
- B. Letter Color: White.
- C. Letter Height: 1/4 inch (6 mm).
- D. Background Color: Black.

2.3 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

2.4 ADHESIVE-BACKED DUCT MARKERS

2.5 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.

2.6 PIPE MARKERS

- A. Color: Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.
- E. Color code as follows:
 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
 2. Toxic and Corrosive Fluids: Orange with black letters.
 3. Compressed Air: Blue with white letters.

2.7 CEILING TACKS

- A. Description: Steel with 3/4-inch (20 mm) diameter color coded head.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing adjusting, and balancing of air systems.
2. Testing adjusting, and balancing of refrigerating systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

B. Related Sections:

1. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. Testing Adjusting and Balancing Bureau:

1. TABB - International Standards for Environmental Systems Balance.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms.
- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty.
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State of California Public Work's standard.
- B. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance.
- C. Maintain one copy of each document on site.
- D. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. HVAC control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.

13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain:
 - 1. Space temperatures within 2 degrees F (1.1 degrees C).
 - 2. Minimal objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches (12.5 Pa) differential static pressure near building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

- N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- O. On fan powered VAV boxes, adjust airflow switches for proper operation.

3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
- C. Confirm air bleeds indicate system is full of water.
- D. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- E. Perform system balance with automatic control valves fully open triple duty valves fully open, and pump VFDs at 100 percent speed.
- F. Confirm pump rotation and differential pressure at full flow.
- G. Perform adjustment of water distribution systems by the following measures:
 - 1. Reduce total system flow rate first by reducing speed of VFD.
 - 2. Use balancing cocks, valves, and fittings.
- H. Do not use service or shut-off valves for balancing unless designed for balancing and shut-off functions. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Air Cooled Refrigerant Condensers.
 - 2. Computer Room Air Conditioning Units.
 - 3. Gravity Ventilators.
 - 4. Fan Coil Units.
 - 5. Fans.
 - 6. Air Filters.
 - 7. Air Inlets and Outlets.

- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 - 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 - 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 - 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
 - 5. Air Cooled Condenser:
 - a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number

- f. Entering DB air temperature, design and actual
- g. Leaving DB air temperature, design and actual
- h. Number of compressors
- 6. Fan Coil Unit Data:
 - a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Size
 - f. Air flow, design and actual
 - g. Entering air DB temperature, design and actual
 - h. Entering air WB temperature, design and actual
 - i. Leaving air DB temperature, design and actual
 - j. Leaving air WB temperature, design and actual
 - k. Entering air temperature, design and actual
 - l. Leaving air temperature, design and actual
 - m. Saturated suction temperature, design and actual
 - n. Air pressure drop, design and actual
- 7. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
- 8. Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore

- j. Number of Belts/Make/Size
- k. Fan RPM
- 9. Duct Traverse:
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
- 10. Duct Leak Test:
 - a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
- 11. Air Monitoring Station Data:
 - a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
- 12. Sound Level Report:
 - a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level - equipment on
- 13. Vibration Test:

- a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (when applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)
 - 8) Duct after flexible connection (discharge)
 - 9) Duct after flexible connection (suction)
- b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
- c. Normally acceptable readings, velocity and acceleration
- d. Unusual conditions at time of test
- e. Vibration source (when non-complying)

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.2 REFERENCES

A. ASTM International:

1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
5. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
6. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
7. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
8. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
9. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
10. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
11. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

12. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
13. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
14. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
15. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
16. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
19. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
20. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
21. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
22. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
23. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
24. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:

1. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Samples: Submit two samples of representative size illustrating each insulation type.

- D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 450 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.
- E. Perform Work in accordance with State of California Public Work's standard.
- F. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for man-made fiber.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Glass Fiber and Mineral Fiber Insulation
 - 1. Manufacturers:
 - a. CertainTeed LLC; Saint-Gobain North America.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
 - f. Substitutions: Section 01 60 00 - Product Requirements.
- B. Closed Cell Elastomeric Insulation
 - 1. Manufacturers:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.

- d. Substitutions: Section 01 60 00 - Product Requirements.

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F (0.034 at 24 degrees C).
 2. Operating Temperature Range: 0 to 850 degrees F (minus 18 to 454 degrees C).
 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 4. Jacket Temperature Limit: minus 20 to 150 degrees F (minus 29 to 66 degrees C).
- B. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.040 at 24 degrees C).
 2. Operating Temperature Range: 0 to 650 degrees F (minus 18 to 343 degrees C).
- C. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 25 degrees C).
 2. Operating Temperature Range: Range: Minus 70 to 180 degrees F (minus 57 to 82 degrees C).
- D. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.30 at 75 degrees F (0.043 at 24 degrees C).
 2. Maximum Service Temperature: 300 degrees F (149 degrees C).
 3. Operating Temperature Range: Range: Minus 58 to 300 degrees F (minus 50 to 149 degrees C).

2.3 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:
1. white Kraft paper with glass fiber yarn, bonded to aluminized film.
 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms (290 ng/Pa/s/m).
- B. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
 2. Thickness: 10 mil (0.25 mm).
 3. Connections: Brush on welding adhesive.
- C. ABS Plastic Pipe Jacket:
1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 2. Minimum service temperature: -40 degrees F (-40 degrees C).
 3. Maximum service temperature of 180 degrees F (82 degrees C).
 4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms (174 ng/Pa/s/m).
 5. Thickness: 30 mil (0.76 mm).

6. Connections: Brush on welding adhesive.

D. Aluminum Pipe Jacket:

1. Thickness: 0.016 inch (0.40 mm) thick sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches (40 mm) diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches (50 mm) diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches (150 mm) long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

G. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.

1. Thermal Conductivity: 0.24 at 75 degrees F (0.035 at 24 degrees C).
2. Operating Temperature Range: 0 to 450 degrees F (minus 18 to 232 degrees C).
3. Density: 1.5 pound per cubic foot (24 kilogram per cubic meter).

B. TYPE E-6: ASTM C553; mineral fiber blanket, Type I.

1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
2. Maximum Operating Temperature: 1000 degrees F (538 degrees C).
3. Density: 1.0 pound per cubic foot (16 kilogram per cubic meter).

- C. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 25 degrees C).
 - 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F (minus 57 to 105 degrees C).

2.6 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:
 - 1. Product Description: ASTM D1785, sheet material, off-white color.
 - 2. Minimum Service Temperature: -40 degrees F (-40 degrees C).
 - 3. Maximum Service Temperature: 150 degrees F (66 degrees C).
 - 4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms (290 ng/Pa/s/m).
 - 5. Thickness: 10 mil (0.25 mm).
 - 6. Connections: Brush on welding adhesive.
- B. Aluminum Equipment Jacket:
 - 1. Thickness: 0.016 inch thick sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
- C. Stainless Steel Equipment Jacket:
 - 1. ASTM A240/A240M OR ASTM 666 Type 302 stainless steel.
 - 2. Thickness: 0.010 inch (mm) thick.
 - 3. Finish: Smooth.
 - 4. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.
- D. Vapor Retarder Jacket:
 - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms (290 ng/Pa/s/m).

2.7 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

- D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- E. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
 - 1. Thermal Conductivity: 0.25 at 75 degrees F (0.036 at 24 degrees C).
 - 2. Maximum Operating Temperature: 250 degrees F (121 degrees C).
 - 3. Density: 1.5 pound per cubic foot (24 kilogram per cubic meter).
- B. TYPE D-5: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.
 - 1. Thermal Conductivity: 0.23 at 75 degrees F (0.033 at 24 degrees C).
 - 2. Density: 3.0 pound per cubic foot (48 kilogram per cubic meter).
 - 3. Maximum Operating Temperature: 250 degrees F (121 degrees C).
 - 4. Maximum Air Velocity: 4,000 feet per minute (20.3 meter per second).
- C. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F (0.039 at 24 degrees C).
 - 2. Service Temperature Range: Range: Minus 58 to 180 degrees F (minus 50 to 82 degrees C).

2.9 DUCTWORK INSULATION JACKETS

- A. Aluminum Duct Jacket:
 - 1. Thickness: 0.016 inch (mm) thick sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 - 4. Fittings: 0.016 inch (mm) thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (mm) thick aluminum.
- B. Vapor Retarder Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms (290 ng/Pa/s/m).
 - 3. Secure with pressure sensitive tape.
- C. Canvas Duct Jacket: UL listed, 6 oz/sq yd (220 g/sq m), plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

2.10 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Adhesive: Waterproof type.
- D. Liner Fasteners: Galvanized steel, self-adhesive pad with head.
- E. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
- F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- H. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.

- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

- D. Glass Fiber Board Insulation:
 - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

- E. Hot Piping Systems less than 140 degrees F (60 degrees C):
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 - 3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

- F. Hot Piping Systems greater than 140 degrees F (60 degrees C):
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 - 3. Insulate flanges and unions at equipment.

- G. Inserts and Shields:
 - 1. Piping 1-1/2 inches (40 mm) Diameter and Smaller: Install steel shield between pipe hanger and insulation.
 - 2. Piping 2 inches (50 mm) Diameter and Larger: Install insert between support shield and piping and under finish jacket.

- a. Insert Configuration: Minimum 6 inches (150 mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install steel shield between roller and inserts.

- H. Insulation Terminating Points:
 1. Coil Branch Piping 1 inch (25 mm) and Smaller: Terminate hot water piping at union upstream of the coil control valve.
 2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
 3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

- I. Closed Cell Elastomeric Insulation:
 1. Push insulation on to piping.
 2. Miter joints at elbows.
 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 4. When application requires multiple layers, apply with joints staggered.
 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

- J. High Temperature Pipe Insulation:
 1. Install in multiple layers to meet thickness scheduled.
 2. Attach each layer with bands. Secure first layer with bands before installing next layer.
 3. Stagger joints between layers.
 4. Finish with canvas jacket.

- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

- L. Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

- M. Prepare pipe insulation for finish painting. Refer to Section 09 90 00.

3.3 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.
- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.
 - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids 140 degrees F (60 degrees C) Or Less:
 - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment Containing Fluids Over 140 degrees F (60 degrees C):
 - 1. Insulate flanges and unions with removable sections and jackets.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.
- G. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
- H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- J. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.

3.4 INSTALLATION - DUCTWORK SYSTEMS

- A. Duct dimensions indicated on Drawings are finished inside dimensions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor retarder jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. External Glass Fiber Duct Insulation:
 - 1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 - 2. Secure insulation without vapor retarder with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- E. External Elastomeric Duct Insulation:
 - 1. Adhere to clean oil-free surfaces with full coverage of adhesive.
 - 2. Seal seams and butt joints with manufacturer's recommended adhesive.
 - 3. When application requires multiple layers, apply with joints staggered.
 - 4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
 - 5. Lift ductwork off trapeze hangers and insert spacers.
- F. Duct and Plenum Liner:
 - 1. Adhere insulation with adhesive for 100 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
 - 3. Seal and smooth joints. Seal and coat transverse joints.
 - 4. Seal liner surface penetrations with adhesive.

5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

G. Ducts Exterior to Building:

1. Install insulation according to duct liner paragraph above.
2. Provide external insulation with vapor retarder jacket.
3. Finish with aluminum duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

- H. Prepare duct insulation for finish painting. Refer to Section 09 90 00.

3.5 SCHEDULES

A. Piping Insulation Schedule:

1. Condensate Piping from Cooling Coils:
 - a. Type: P-5.
 - b. Thickness: 0.5 inch (12 mm).
2. Refrigerant Suction:
 - a. Type: P-5.
 - b. Thickness: 1 inch (25 mm).
3. Refrigerant Hot Gas:
 - a. Type: P-5.
 - b. Thickness: 1 inch (25 mm).

B. Ductwork Insulation Schedule:

1. Supply Ducts - Internally Insulated:
 - a. Type: D-5.
 - b. Thickness: 1.0 inch (25 mm).
2. Return Ducts - Internally Insulated:
 - a. Type: D-5.
 - b. Thickness: 1.0 inch (25 mm).
3. Supply Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1.
 - b. Thickness: 1.5 inches (38 mm).
4. Return Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1.
 - b. Thickness: 1.5 inches (38 mm).
5. Transfer Air Ducts - Internally Insulated:
 - a. Type: D-5.
 - b. Thickness: 1.0 inches (25 mm).

END OF SECTION 23 07 00

SECTION 23 09 13 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating 2018.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
- C. ASTM B32 - Standard Specification for Solder Metal 2008 (Reapproved 2014).
- D. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2016.
- E. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2018.
- F. ASTM B819 - Standard Specification for Seamless Copper Tube for Medical Gas Systems 2018.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2018.

1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system. D. Manufacturer's Qualification Statement.
- D. Installer's Qualification Statement.
- E. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

1.3 WARRANTY

- A. Correct defective work within a five year period after Substantial Completion.
- B. Provide five year manufacturer's warranty for control air compressors.

PART 2 - PRODUCTS

2.1 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.2 UNIVERSITY GUIDELINES AND REQUIREMENTS

A. TEMPERATURE SENSORS:

- 1. Resistance Temperature Detectors (RTD's):
 - a. Standard: Siemens 1000 Ohm Platinum RTD, Model Number PTM6.2P1K.
 - b. Exception: Thermistors are required in some zone applications such as VAV boxes, and may only be used in those areas.
 - c. Function: Use for air handlers, Hot Water (HW) and Chilled Water (CHW). Do not install in piping tee. Connect to Energy Management System (EMS) by Siemens.

B. DIFFERENTIAL PRESSURE SENSORS:

- 1. Resistance Temperature Detectors (RTD's):
 - a. Siemens Sitrans 7MF4433 with 3-valve manifold and local display.
 - b. Standard: Emerson Process Management, Rosemount Model #1151 Pressure Transmitter. Connect to Energy Management System (EMS) by Siemens. Specify pressure range for 150% of maximum expected differential pressure.
 - c. Function: Measure differential pressure for monitoring and control of variable speed pumps.
 - d. Website:
<http://www.emersonprocess.com/rosemount/Products/Pressure/m1151.html>

C. MOTOR CONTROLS:

- 1. Campus Standard: ABB ACH550. Enclosure: UL (NEMA) Type 12. Integral disconnect. No bypass. No known equal.
- 2. Function: Connect to Campus Energy Management System (EMS) by Siemens as a Field Level Network (FLN) device to provide direct communication (not hardwired start/stop/status). Proof through drive and via current switches.

2.3 AIR SUPPLY SYSTEM

- A. Compressor and Receivers:
 - 1. Simplex belt driven air compressor and tank unit with belt guard, silencers, flexible connections, air filter, automatic and manual drain assemblies, oil and particle filter for minimum 0.5 micron particles, pressure reducing valves, and pressure relief valves.
 - 2. Pressure Control: Zinc or aluminum castings, rated for service with elastomeric diaphragm, adjustable electric contacts.
 - a. Set to start and stop compressor at 50 and 60 psig (340 and 445 kPa).
 - 3. Electrical Alternation Set: With motor starters to operate compressors alternately.
- B. Pressure Regulators:
 - 1. Zinc or aluminum castings, rated for service with elastomeric diaphragm, balanced construction to automatically prevent pressure build up, and producing flat, reduced pressure curve for system capacity demand.
- C. Particle Filters:
 - 1. Zinc or aluminum castings with filtration efficiency at rated air flow of 97 percent, rated for service with threaded connections, quick-disconnect service devices, aluminum bowl or plastic bowl with metal guard equipped with manual drain cock, to separate liquid and solid particles.
- D. Combination Filter/Regulators:
- E. Zinc or aluminum castings, rated for service with elastomeric diaphragm, balanced construction to automatically prevent pressure build up, and producing flat, reduced pressure curve for system capacity demand; with threaded pipe connections, quickdisconnect service devices, aluminum bowl or plastic bowl with metal guard equipped with manual drain cock to separate liquid and solid particles.
- F. Airborne Oil Filters:
 - 1. Rated for service with filtration efficiencies of 99.9 percent for particles of 0.025 micron or larger particles of airborne lubricating oil.
- G. Pressure Relief Valves:
 - 1. ASME Code Rated and labeled for high pressure side and sized for installed capacity of pressure regulators at low pressure. Set at maximum 20 percent above low pressure.
- H. Pressure Reducing Stations:
 - 1. Assembly of two pressure regulators arranged in parallel to reduce high pressure air to required controls pressure.

- I. Control and Instrumentation Tubing:
 - 1. Copper Tube: ASTM B819 Type K, or ASTM B88 (ASTM B88M) Type K (A), seamless, H or O temper (drawn or annealed).
 - a. Fittings: ASME B16.22, wrought copper.
 - b. Joints: Solder, lead free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.
- J. Refrigerated Air Dryers:
 - 1. General Assembly: Self-contained, commercial quality, refrigerated, compressed air dryer complete with heat exchangers, moisture separator, and internal wiring and piping. Provide air inlet and outlet connections connected through manual by-pass valve.
 - 2. Heat Exchangers: Air to refrigerant coils. Provide centrifugal type moisture separator located at discharge of compressed air complete with automatic trap assembly. Provide automatic control system to bypass refrigeration system on low or no load conditions.
 - 3. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 0 degrees F (minus 18 degrees C) at 20 psig (138 kPa). House in steel cabinet with access door and panel.

2.4 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.

2.5 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage, 0.1046 inch (2.66 mm).
- C. Blades: Galvanized steel, maximum blade size 8 inches (200 mm) wide, 48 inches (1200 mm) long, minimum 22 gage, 0.0299 inch (0.76 mm), attached to minimum 1/2 inch (13 mm) shafts with set screws.

2.6 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against

maximum system pressures. Provide spring return for two position control and for fail safe operation.

1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

B. Pneumatic Operators:

1. Rolling diaphragm piston type with adjustable stops.
2. Pilot Positioners: Starting point adjustable from 2 to 12 psig (15 to 83 kPa) and operating span adjustable from 5 to 13 psig (35 to 90 kPa).

C. Electric Operators:

1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

D. Inlet Vane Operators:

1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.

2.7 HUMIDISTATS

A. Room Humidistats:

1. Wall mounted, proportioning type.

B. Limit Duct Humidistats:

1. Insertion, two position type.

2.8 INPUT/OUTPUT SENSORS

A. Temperature Sensors:

1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.

B. Carbon Dioxide Sensors, Duct and Wall:

1. General: Provide non-dispersive infrared (NDIR), diffusion sampling CO₂ sensors with integral transducers and linear output.

2.9 THERMOSTATS

A. Pneumatic Room Thermostats:

B. Electric Room Thermostats:

C. Line Voltage Thermostats:

D. Airstream Thermostats:

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 09 13

SECTION 23 09 23 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL (NOT APPLICABLE)

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED PRODUCTS

- A. New Products: Johnson Controls.

2.2 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.3 OPERATOR INTERFACE

- A. PC Based Work Station:
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.

2.4 CONTROLLERS

A. BUILDING CONTROLLERS

1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

B. INPUT/OUTPUT INTERFACE

1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

2.5 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F (0 to 50 degrees C).
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.6 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If

transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.7 SYSTEM SOFTWARE

A. Operating System:

1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems: Windows 7.
2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - a) Analog and binary values.
 - b) Dynamic text.
 - c) Static text.
 - d) Animation files.
3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - b. Ancillary Equipment:

B. Workstation System Applications:

1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.

- c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
9. Configurable Alarm Reactions by Workstation and Time of Day:

- a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
10. Custom Trend Logs:
- a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
11. Alarm and Event Log:
- a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
12. Object, Property Status and Control:
- a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
13. Reports and Logs:
- a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).

14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - a) Alarm History.
 - b) System messages.
 - c) System events.
 - d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - a) Monthly showing daily natural gas consumption for each meter.
 - b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- C. Workstation Applications Editors:
1. Provide editing software for each system application at PC workstation.
 2. Downloaded application is executed at controller panel.
 3. Full screen editor for each application allows operator to view and change:

- a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
4. Scheduling:
- a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
- a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.8 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support Inch-pounds and SI (metric) units of measurement.
 - 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 - 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- C. Refer to Section 23 09 93.
- D. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

END OF SECTION 23 09 23

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SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Central fan systems.
 - 2. Fan coil units.

1.2 RELATED REQUIREMENTS

- A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- B. Section 23 09 23 - Direct-Digital Control System for HVAC.

1.3 SUBMITTALS

- A. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
- B. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
- C. Points List: Submit list of all control points indicating at least the following for each point.
- D. Designer's Qualification Statement.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 09 93

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EXHIBIT 23 09 95A - Pre Functional Checklist Sample
Cal Poly - Vista Grande Dining Facility

System Type: Air Handler Unit

PFC FORM ID: ____

Equipment Tag (ID): (AH-____)

A. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunctional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.

General Contractor	Date
Mechanical Contractor	Date
Electrical Contractor	Date
Controls Contractor	Date

Pre-functional checklist items are to be completed as part of start-up & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and start-up procedures or report
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others)
- If this form is not used for documenting, one of similar rigor shall be used.
- General contractor shall assign checklist sections to the respective sub-contractors. General contractor shall be responsible to see that the checklist items by their sub-contractors are completed and checked off.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted in the issues log.

Commissioning Authority	Date
-------------------------	------

B. Model Verification

Enter nameplate information; Verify installed units match approved submittals

	AH-1
Manufacturer	
Model	
Serial Number	
CFM	
Cooling Capacity (MBH)	
Heating Capacity (MBH)	

C. Pre-Functional Checks

Check (✓) if Okay. Enter "N/A" if not applicable. Enter note number if deficient.

Tag	Inspection Item	Equipment Tag		Comments
		AH-1		
1	DOCUMENTATION			
	<i>Verify if the following items have been submitted:</i>			
1.01	Manufacturer's cut sheets including performance data (if available)			
1.02	Installation and startup manual / plan			
1.03	O&M manuals			
1.04	Control sequences			

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Tag	Inspection Item	AH-1		Comments
2	CABINET AND GENERAL INSTALLATION			
2.01	Permanent labels affixed - indoor and outdoor units			
2.02	Casing condition good: no dents, leaks, door gaskets installed			
2.03	Access doors close tightly - no leaks			
2.04	Boot between duct and unit tight and in good condition			
2.05	Vibration isolation equipment installed & released from shipping locks			
2.06	Maintenance access acceptable for unit and components			
2.07	Sound attenuation installed (if applicable)			
2.08	Thermal insulation properly installed according to specifications			
2.09	Instrumentation installed according to specifications (temperature gauges, pressure gages, flow meters, etc.)			
2.10	All the duct connections to the cabinet are air tight and insulated			
2.11	Filters installed and replacement type and efficiency label permanently affixed to housing - construction filters removed			
3	VALVES, PIPING AND COILS			
3.01	Pipe fittings complete and pipes properly supported			
3.02	Piping properly labeled			
3.03	Piping properly insulated			
3.04	Piping properly flushed			
3.05	No leaks apparent around fittings			
3.06	All coils are clean and are in good condition			
3.07	All condensate drain pans clean and slope to drain, per spec			
3.08	Valves installed in proper direction			
3.09	Valves properly labeled			
3.10	Pressure / Temperature (P/T) plugs and isolation valves installed (per drawings)			
3.11	Piping through exterior walls is weather sealed			
4	FANS AND DAMPERS			
4.01	Supply fan and motor alignment appear correct			
4.02	Supply fan belt tension and condition appear OK (if applicable)			
4.03	Supply fan protective shrouds for belts in place and secure (if applicable)			
4.04	Supply fan area clean			
4.05	Supply fan and motor properly lubricated			
4.06	Smoke and fire dampers installed properly per contract documents (proper location, access doors, appropriate ratings verified)			
4.07	All dampers close tightly			
4.08	All damper linkages have minimum play			
4.09	Filters clean and tight fitting			
4.10	Filter pressure differential measuring device installed and functional (magnahelic, inclined manometer, etc.)			
5	DUCTING			
5.01	Duct joint sealant properly installed			
5.02	No apparent severe duct restrictions			
5.03	Turning vanes installed in square elbows (if applicable)			
5.04	OSA intakes located away from pollutant sources & exhaust outlets			
5.05	Pressure leakage tests completed (if applicable)			
5.06	Branch duct control dampers operable (if applicable)			
5.07	Ducts cleaned as per specifications			
5.08	Balancing dampers installed as per drawings and TAB company site visit			
5.09	Sound attenuators installed (if applicable)			
6	ELECTRICAL			
6.01	Power disconnects in place and labeled			
6.02	All electric connections tight			
6.03	Proper grounding installed for unit and components			
6.04	Safeties in place and operable			
6.05	Breaker size and type correct			
6.06	Power disconnect located within sight of unit controller (per electrical code)			

Tag	Inspection Item	AH-1		Comments
7	CONTROLS			
7.01	Control system interlocks hooked up and functional			
7.02	Related thermostats are installed			
7.03	Related building automation system points are installed			
7.04	All control devices and wiring complete			
7.05	Sensors calibrated (per specifications)			
7.06	Specified sequences of operation and operating schedules have been implemented with all variations documented			
7.07	Specified point-to-point checks have been completed and documentation record submitted for this system			
7.08	Variable Frequency Drive (VFD): Related Pre-Functional Checklist (PFC) form completed			
8	VARIABLE FREQUENCY DRIVE (VFD)			
8.01	VFD powered (wired to controlled equipment)			
8.02	VFD interlocked to control system (checked by installer)			
8.03	Controlling sensor properly located & per drawings & calibrated			
8.04	Drive location not subject to excessive temperature (high/low), moisture, or dirt			
8.05	Drive size matches motor size			
8.06	Motor is rated for use with VFDs			
8.07	Internal setting designating the model is correct			
8.08	Input of motor FLA represents 100% to 105% of motor FLA rating			
8.09	Appropriate Volts vs Hz curve is being used			
8.10	Accel and decel times are around 10-50 seconds, except for special applications. Actual decel = _____ Actual accel = _____			
8.11	Upper frequency limit set at 100%, unless explained otherwise			
8.12	Lower frequency limit at 10-15% for VAV fans and around 10-30% for chilled water pumps; or as dictated in the specifications. Record actual for each unit.			
8.13	Motor full load speed setting. Acceptance: Equal to motor rating.			
8.14	Motor frequency setting. Acceptance: same as rated motor freq.			
8.15	Motor line voltage setting. Acceptance: same as rated motor voltage, usually 460 volts.			
8.16	No disconnects installed between VFD & motor without shutdown interlock to VFD			
8.17	Shutdown interlocks between VFD & motor verified to be operational			
8.18	Separate conduit for VFD incoming power & outgoing motor leads			
8.19	Bypass contactor operation verified; Fan rotation correct with bypass operation			
9	OPERATIONAL			
9.01	Supply fan rotation correct			
9.02	Supply fan - No unusual vibration or noise			
9.03	CHW & HHW valves stroke fully and easily and spanning is calibrated			
9.04	Valves verified to not be leaking through coils when closed at normal operating pressure			
9.05	The HOA switch properly activates and deactivates the unit			
9.06	If supply fan is > 5 HP, measure line-to-line voltage imbalance. (If VFD-equipped, measure upstream of VFD). (% Imbalance = 100 x (max. deviation from avg.) / avg.) Fan motor (line-to-line voltage): a) Ph 1: _____, b) Ph 2: _____ c) Ph 3: _____ d) Average voltage: _____ e) % Imbalance: _____ f) Is imbalance less than 2%? (Yes/No)	a) _____ b) _____ c) _____ d) _____ e) _____ f) _____		
9.07	If supply fan is > 5 HP - Verify full load running amps. (If VFD-equipped, measure upstream of VFD). a) Rated Amps: _____ Rated FL amps x _____ svc factor = _____ (Max amps) b) Measured Amps: _____ c) Running less than max? (Yes/No)	a) _____ b) _____ c) _____		

Tag	Inspection Item	AH-1		Comments
10	FINAL			
10.01	If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas.			
10.02	Safeties installed and safe operating ranges for this equipment provided to the commissioning agent			
10.03	Startup report completed with this checklist attached			
10.04	Clean up of equipment and surrounding areas completed			
10.05	Construction filters removed before occupancy. Replace with clean filters at start of occupancy (or per specifications)			

D. Notes

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Exhibit 23 09 05B

Functional Test Procedure Sample

Cal Poly - Vista Grande Dining Facility

System: Airside Systems (AHU, VAVs)

Date: _____

1. Objective:

- a. Confirm satisfactory operation of airside system(s)

2. Equipment:

	EQUIPMENT ID	DESCRIPTION
1.	AHU-__	Air Handler
2.	VAV __ to __	Variable Air Volume (VAV) Terminals
3.		

3. Participants

	NAME	COMPANY	FUNCTION	ROLE
1.				Party filling out this form and witnessing the test
2.				Party operating equipment and executing the test

4. Prerequisite Checklist:

	ITEM	√
1.	Pre-functional checks complete	
2.	TAB complete and zone design lows previously verified	
3.	All safety devices (such as high pressure and low pressure switch) have been checked	
4.	VFD start-up and testing complete	

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	ITEM	√
5.	Occupants (if any) notified that testing in progress and zone temperatures will be significantly out of normal range	
6.	No interior dust or fumes in the building	
7.	BAS system able to display real time measured condition in the air handler and in all zones	
8.	All fire dampers open	
9.	Condensate trap at the air handler is primed	

5. Seasonal Testing Note:

Due to the building completion being during winter, this test will be completed in two stages. The first testing will occur during cold weather. The objective of this first stage test is to provide reasonable assurance that the air handler will function properly during lower load conditions. This will prepare the air handler for operation during the beginning of the cooling season. As many of the test procedures as possible will be executed during this first stage of testing, through the use of the methods of artificial loading or partial loading. Tests for full load condition will not be able to be executed until summer.

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6. Procedure:

Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #
1	<p><u>AHU Disable</u></p> <p>Standby Check with AHU commanded off by BAS.</p>	<p>Verify by visual inspection that:</p> <p>Supply fan and return fan on AHU slowly ramps down (through VFDs) and comes to a stop</p> <p>Cooling Coil Valve on AHU is Closed</p> <p>OSA Dampers are closed</p> <p>Return Air Damper is open</p>	<p>Supply & Return Fans Off: YES / NO</p> <p>Valve Closed: YES / NO</p> <p>OSA Damper Closed: YES / NO</p> <p>Return Air Damper Open: YES / NO</p>		
2	<p><u>AHU Enable</u></p> <p>Operation check with AHU commanded to Occupied Mode by BAS</p>	<p>Verify by visual inspection that:</p> <p>OSA damper opens to min position (economizer verified in a later test)</p> <p>Return Air Damper is open</p> <p>Supply fan and return fan on AHU slowly ramp up (through VFDs) and stabilize to maintain duct static pressure</p>	<p>OSA Damper Open: YES / NO</p> <p>Return Air Damper Open: YES / NO</p> <p>Supply & Return Fans On: YES / NO</p>		

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Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #
3	<p><u>Basic AHU Operation</u></p> <p>Lockout any CHW cooling during this test. Set all VAVs to 100% Open and temporarily set duct static pressure setpoint to 0.75". Observe VFD speed.</p> <p>Slowly raise duct static setpoint until VFD reaches 100% rated speed</p>	<p>VFD speed shall ramp up to maintain static pressure setpoint</p> <p>As duct static pressure setpoint is increased, VFD speed shall ramp up until reaching max speed</p>	<p>Supply Fan Speed (%): _____</p> <p>Fan speed tracks to maintain static sp: YES / NO</p> <p>Duct static sp to reach max VFD speed: _____ in w.g.</p> <p>Supply Fan Speed (%): _____</p> <p>Fan speed tracks to maintain static sp: YES / NO</p> <p>Unusual noise or vibration: YES / NO</p> <p>Unusual dust loading in AHU chamber: YES / NO</p>		
4	<p><u>Zone VAV Box Basic Operation</u></p> <p>Lockout any CHW cooling during this test. Manually open VAV boxes to 100% open and lock AHU supply fan speed at approximately 80% (or 48 Hz). Observe flows at VAVs.</p>	<p>Flows at each VAV shall be approximately 60 – 80% of max rated VAV flow.</p>	<p>Supply Fan Seed: _____ (%)</p> <p>Duct Static Pressure: _____ in w.g.</p> <p>Air Flows at VAVs normal: YES / NO</p>		

**VISTA GRANDE FACILITY REPLACEMENT
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Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #
4 (Cont.)	<p><u>Zone VAV Box Basic Operation</u></p> <p>Fully close one quarter of VAV box dampers and observe the air flow leakage. Note the change in static pressure. Return VAV dampers to their full open position. Repeat procedure for other VAV dampers (one quarter of total VAVs at one time).</p>	<p>Air flow shall be zero (or near zero) with VAV box damper fully closed. Duct static pressure shall increase with the closure of VAV boxes.</p>	<p>Quarter of VAVs closed: (1 of 4) Static pressure: _____ in. w.g.</p> <p>Quarter of VAVs closed: (2 of 4) Static pressure: _____ in. w.g.</p> <p>Quarter of VAVs closed: (3 of 4) Static pressure: _____ in. w.g.</p> <p>Quarter of VAVs closed: (4 of 4) Static pressure: _____ in. w.g.</p> <p>Record individual VAV flows with damper fully closed in VAV detail sheet.</p>		
5	<p><u>Zone Reheat Coil Basic Operation</u></p> <p>Lockout any CHW cooling during this test. Open up all boxes to min. flow position. With all reheat coils initially off, observe discharge air temperatures (DAT) for each zone.</p> <p>Open all reheat coils to 100% and observe the increase in supply air temperature.</p> <p>Fully close all reheat coils and observe the decrease in supply air temperature.</p>	<p>Discharge air temperature (DAT) at VAV shall be similar to AHU discharge air temperature (DAT).</p> <p>Discharge air temperature shall increase with opening of reheat coil valves</p> <p>Discharge air temperature shall decrease to normal levels (i.e., close to AHU discharge temp) with closure of reheat coil valves. If discharge air temp does not drop, it can be a sign of leaking HW valves</p>	<p>AHU DAT: _____ deg.F Range of VAV DATs: _____ deg.F</p> <p>AHU DAT: _____ deg.F Range of VAV DATs: _____ deg.F</p> <p>Discharge air temperatures normal after closure of reheat valves: YES / NO</p>		

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Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #
6	<p><u>Cooling Coil Valve Control</u></p> <p>Lock out economizer during this test. Set all VAVs to minimum flow to simulate a low flow condition. Set supply air temp. (SAT) setpoint to 60 deg.F and observe CHW coil response.</p> <p>Lower supply air temperature (SAT) setpoint to 55 deg.F and observe CHW coil response.</p> <p>Open VAVs to achieve max rated airflow. Observe CHW coil response.</p>	<p>Chilled water valve shall modulate to maintain the supply air temperature setpoint.</p> <p>CHW valve shall open up more to maintain the lower supply air temperature setpoint.</p> <p>CHW valve shall open up more to maintain the higher air flow rates.</p>	<p>Supply Fan CFM: _____ MAT / SAT: _____ / _____ deg.F CHW Valve Position: _____ % Open CHW Temp (Sup/Ret): ____/____ deg.F</p> <p>Supply Fan CFM: _____ MAT / SAT: _____ / _____ deg.F CHW Valve Position: _____ % Open CHW Temp (Sup/Ret): ____/____ deg.F</p> <p>Supply Fan CFM: _____ MAT / SAT: _____ / _____ deg.F CHW Valve Position: _____ % Open CHW Temp (Sup/Ret): ____/____ deg.F</p> <p>CHW modulates to achieve setpoint within reasonable time: YES / NO</p>		
7	<p><u>Minimum Outdoor Air Control</u></p> <p>Lock out economizer during this test. Set all VAVs to minimum flow to simulate a minimum supply flow condition. Observe outside air (OSA) damper and flow rate.</p> <p>Set all VAVs to max flow to simulate a max design supply flow condition. Observe outside air (OSA) damper and flow rate.</p>	<p>OSA damper shall modulate to maintain the OSA flow CFM setpoint of _____. Damper shall stabilize within 15 minutes.</p> <p>OSA damper shall modulate to maintain the OSA flow CFM setpoint of _____. Damper shall stabilize within 15 minutes.</p>	<p>Supply Fan Speed: _____(%) Supply Fan CFM: _____ OSA CFM: _____ OSA Damper Position: _____ (%) Time for damper to stabilize: _____ min</p> <p>Supply Fan Speed: _____(%) Supply Fan CFM: _____ OSA CFM: _____ OSA Damper Position: _____ (%) Time for damper to stabilize: _____ min</p>		

**VISTA GRANDE FACILITY REPLACEMENT
MAJ 15-MJ0061**

Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #										
8	<p><u>Economizer Control</u></p> <p><i>Warm OSA Condition (i.e., Economizer Off):</i> Set the system to cooling mode. Simulate a condition such that OSA temp is more than 1 deg.F greater than return air temp, and/or OSA is more than econ high limit temp (i.e., 69 deg.F.)</p> <p><i>Cool OSA Condition (i.e., Economizer On):</i> Set the system to cooling mode. Simulate a condition such that OSA temp is less than return air temp, and OSA is less than econ high limit temp (i.e., 69 deg.F.)</p> <p><i>Cold OSA Condition (i.e., Economizer On):</i> Set the system to cooling mode. Simulate a condition such that OSA temp is less than supply air temp setpoint.</p> <p>Ensure building pressures during economizer operation are adequate.</p>	<p>OSA damper (OAD) shall remain in min position while CHW cooling coil opens to maintain supply air setpoint. Return air damper (RAD) shall remain fully open.</p> <p>OAD shall open to 100%. CHW valve shall modulate to maintain supply air setpoint.</p> <p>OAD shall modulate in association with the RAD to produce air at the supply air temperature setpoint. CHW valve shall remain closed.</p> <p>Exhaust air damper (EAD) shall modulate to maintain building dp setpoint of 0.02" W.C.</p>	<p>OAD remains in min. position: YES / NO RAD remains fully open: YES / NO</p> <p>OAD damper modulates 100% Open: YES / NO RAD modulates fully closed: YES / NO CHW valve modulates open to maintain SAT setpoint: YES / NO</p> <p>OAD and RAD modulate to maintain SAT setpoint: YES / NO CHW valve remains closed: YES / NO</p> <p>EAD modulates to maintain building pressure setpoint: YES / NO</p>												
9	<p><u>SAT Reset</u></p> <p>Supply air temperature (SAT) shall be reset based on OSA temperature. Simulate various OAT conditions and verify SAT resets accordingly.</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">SAT (deg.F)</th> <th style="text-align: center;">OAT (deg.F)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">58</td> <td style="text-align: center;">55 and below</td> </tr> <tr> <td style="text-align: center;">57</td> <td style="text-align: center;">60</td> </tr> <tr> <td style="text-align: center;">56</td> <td style="text-align: center;">65</td> </tr> <tr> <td style="text-align: center;">55</td> <td style="text-align: center;">70 and above</td> </tr> </tbody> </table>	SAT (deg.F)	OAT (deg.F)	58	55 and below	57	60	56	65	55	70 and above	<p>SAT setpoint is reset per the provided schedule: YES / NO</p>		
SAT (deg.F)	OAT (deg.F)														
58	55 and below														
57	60														
56	65														
55	70 and above														

**VISTA GRANDE FACILITY REPLACEMENT
MAJ 15-MJ0061**

Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #
10	<p><u>VFD Response to Zone Air flow Demand</u></p> <p>Lock out the economizer. Lockout static pressure reset. Set static setpoint to 1.2 in. w.g. Drive 100% of the VAV boxes served by the AHU to minimum flow position.</p> <p>Drive 50% of the VAV boxes served by the AHU to minimum flow position.</p> <p>Drive 0% of the VAV boxes served by the AHU to minimum flow position (i.e., max flow).</p>	<p>VFD shall ramp up fan speed to provide more air flow as more VAV box dampers open</p> <p>VFD shall ramp up fan speed to provide more air flow as more VAV box dampers open</p> <p>VFD shall ramp up fan speed to provide more air flow as more VAV box dampers open</p>	<p><i>100% of VAVs at Min Flow:</i> Supply Static SP (in. wg): _____ Supply Fan CFM: _____ Supply Fan Speed: _____ (%)</p> <p>Return Fan CFM: _____ Return Fan Speed: _____ (%)</p> <p>OSA CFM: _____ OSA Damper: _____ (%)</p> <p><i>50% of VAVs at Min Flow:</i> Supply Static SP (in. wg): _____ Supply Fan CFM: _____ Supply Fan Speed: _____ (%)</p> <p>Return Fan CFM: _____ Return Fan Speed: _____ (%)</p> <p>OSA CFM: _____ OSA Damper: _____ (%)</p> <p><i>0% of VAVs at Min Flow:</i> Supply Static SP (in. wg): _____ Supply Fan CFM: _____ Supply Fan Speed: _____ (%)</p> <p>Return Fan CFM: _____ Return Fan Speed: _____ (%)</p> <p>OSA CFM: _____ OSA Damper: _____ (%)</p> <p>VFD speed modulates to maintain the required flow at the zone: YES / NO</p>		

**VISTA GRANDE FACILITY REPLACEMENT
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Proced. ID	Sequence/Test	Expected Response	Actual Response	Pass (Y/N)	Note #
11	<p><u>Static Reset</u></p> <p>Supply air static set-point shall be reset up or down based on pressure requests.</p>	<p>Static set-point shall be increased if there are more than <u>two</u> pressure requests (i.e., VAV damper > 80% open = 1 request; VAV damper > 95% open = 2 requests)</p> <p>Static set-point shall be increased if there are no pressure requests</p> <p>Static set-point High Limit: <u>1.2</u> " w.c. (as determined by air balancer per specified procedure)</p> <p>Static set-point Low Limit: <u>0.4</u> " w.c.</p>	<p>Static set-point resets up satisfactorily: YES / NO</p> <p>Static set-point resets down satisfactorily: YES / NO</p>		
12	<p><u>Alarms</u></p> <p>Alarm shall be triggered if the filter pressure drop exceeds 0.8 in. w.c. at design supply air CFM. The alarm shall vary with fan speed as is outlined in the sequence of operations.</p>		<p>Filter Alarm is functional: YES / NO</p>		

Notes:

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SECTION 23 09 95 - MECHANICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. System specific commissioning
- B. Related Sections:
 - 1. Section 01 91 15, "General Commissioning Requirements"
 - 2. Section 01 33 00, "Submittal Procedures"
 - 3. Section 01 70 00, "Project Closeout"

1.2 DESCRIPTION OF WORK - REFER TO SECTION 01 91 15

1.3 SUBMITTALS - REFER TO SECTION 01 91 15

PART 2 - PRODUCTS - REFER TO SECTION 01 91 15

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS AND PROCEDURES - REFER TO SECTION 01 91 15

3.2 PRE-FUNCTIONAL CHECKLIST

- A. Pre-Functional Test is defined under Section 01 91 15. Only the sample checklists are provided in this section as Exhibit 23 09 05-A as an indication of the format and rigor of the required pre-functional checklists and documentation. Though not developed specifically for this project, they show the extent of checks involved associated with typical installations. Actual Pre-Functional Checklist shall be prepared by the CA upon review of all the contractor submittals, including manufacturer's installation instructions and O&M manuals.
- B. These checklists do not take the place of the manufacturer's recommended checkout and start-up procedures or report.
- C. Regardless of whether the CA includes them or not, checks, inspections, safety measures, quality control measures and start-up procedures recommended by the manufacturer shall be implemented by the Contractor prior to initiation of the commissioning activity.

- D. The Commissioning Coordinator (CC) employed by the Contractor shall be responsible for directing all Pre-Functional Check lists provided by the CA. The CC shall engage subcontractors and vendors service representatives with expertise in the specific equipment or system to determine whether the equipment or system passes the checks detailed in the Pre-Functional Checklist.
- E. CC shall communicate the actual schedule for the execution of the Pre-Functional Checks to the CA as provided under Section 01 91 15.
- F. The Commissioning Authority (CA) may choose to participate in the inspection of items along with the Contractor and specialty subcontractors and vendors. In addition, CA reserves the right to inspect any or all of the items on his own in order to satisfy that the installation conforms to the design objectives and the system is ready for Functional Testing.
- G. For additional information on how the Pre-Functional Checklists fits within the overall framework of Commissioning as well as the Contractor's obligations under the same, please see Section 01 91 15.

3.3 FUNCTIONAL PERFORMANCE TEST PROCEDURES (FPTs)

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Contractor shall assist the Commissioning Authority (CA) in developing the Working Functional Performance Test (FPT) Procedures as specified in Section 01 91 15. For any given equipment or system subcontractors and equipment suppliers associated with and specializing in the specific equipment are required to participate in developing the working procedures for the indicated FPTs. It is conceivable that for certain equipment and systems, multiple subcontractors and specialties may be required to participate to contribute to the development of the Functional Test. Contractor shall extend his full cooperation to the CA in securing the subcontractor or supplier resources necessary to develop and implement the Functional Tests.
- B. The Contractor's Commissioning Coordinator is required to manage the subcontractors in developing the Working FPT Procedures and Data Forms, and in performing all FPT's.
- C. Though not developed specifically for this project, the sample Functional Test Procedures shown under Exhibit 23 09 05-B are provided as an indication of the format and rigor of the required Functional Testing procedures and documentation.
- D. CA may approve certain equipment performance tests to be conducted at the factory. If so, Contractor shall make arrangements and pay for travel costs for Owner and the CA to visit the factory and witness such tests at the factory.

- E. Contractor shall be responsible for demonstrating the successful testing of 100% of the systems to be commissioned per the Functional Test plans and procedures provided by the CA.
- F. CA shall develop the Functional Test following review of all contractor submittals. The Functional Test documents shall be made available immediately upon the successful completion of the Pre-Functional Check Lists and correction of all issues identified in the Pre-Functional Checklist.
- G. Contractor shall allow a reasonable time frame after the completion of TAB activities to schedule and conduct the Functional Tests. Functional tests shall commence only upon completion of the TAB activities and all flows and measurement data established through the TAB process are available for the Commissioning Agent's review. In no event shall the commissioning Functional Test duration be less than four weeks, plus what is reasonably required to correct issues identified and time required for retest and backcheck. Contractor shall coordinate the work of other disciplines so that commissioning test procedures are not interrupted as a result of work that needs to be performed inside or outside the building.
- H. Refer to Section 01 91 15 for additional requirements regarding Functional Tests.

END OF SECTION 23 09 95

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Unions, flanges, and couplings.
3. Pipe hangers and supports.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant strainers.
7. Refrigerant pressure regulators.
8. Refrigerant pressure relief valves.
9. Refrigerant filter-driers.
10. Refrigerant solenoid valves.
11. Refrigerant expansion valves.
12. Electronic expansion valves.
13. Refrigerant receivers.
14. Underground pipe markers.
15. Bedding and cover materials.

B. Related Sections:

1. Section 05 12 00 - Structural Steel Framing: Product requirements for touch-up painting of structural steel.
2. Section 05 21 00 - Steel Joist Framing: Product requirements for touch-up painting of steel joists.
3. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
4. Section 08 31 13 - Access Doors and Frames: Access doors for concealed valves and accessories.
5. Section 09 90 00 - Painting and Coating: Product requirements for painting for placement by this section.
6. Section 23 05 03 - Pipes and Tubes for HVAC Piping and Equipment: Piping materials for refrigerant systems.
7. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.

8. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
9. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
10. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
11. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
12. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
13. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
14. Section 31 23 16.13 - Trenching: Execution requirements for trenching required by this section.
15. Section 31 23 23 - Fill: Execution requirements for backfilling required by this section.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 1. ARI 495 - Refrigerant Liquid Receivers.
 2. ARI 710 - Liquid-Line Driers.
 3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
 4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
 5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. American Society of Mechanical Engineers:
 1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 3. ASME B31.5 - Refrigeration Piping.
 4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. ASTM International:
 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 4. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).

5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 7. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- C. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories.

2. Valves: Submit manufacturer's catalog information with valve data and ratings for each service.
 3. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
 4. Refrigerant Specialties: Submit manufacturer's catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
 - a. Refrigerant moisture and liquid indicators.
 - b. Refrigerant strainers.
 - c. Refrigerant pressure regulators.
 - d. Refrigerant pressure relief valves.
 - e. Refrigerant filter-driers.
 - f. Refrigerant solenoid valves.
 - g. Refrigerant expansion valves.
 - h. Electronic expansion valves.
- D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of refrigerant leak test.
- F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- H. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- 1.5 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
 - B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
 - C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.
- 1.6 QUALITY ASSURANCE
- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

- B. Perform Work in accordance with applicable code for welding hanger and support attachments to building structure.
- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.
- C. Design piping system, hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1.13 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for valves excluding packing.

1.14 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.15 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each size and valve type.
- C. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, drawn.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).

2.2 UNIONS, FLANGES, AND COUPLINGS

- A. 2 inches (50 mm) and Smaller:

1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. 2-1/2 inches (65 mm) and Larger:
1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 2. Copper Piping: Bronze.
 3. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene.
- C. Grooved and Shouldered Pipe End Couplings:
1. Housing Clamps: Malleable iron to engage and lock designed to permit some angular deflection, contraction, and expansion.
 2. Sealing Gasket: C-shape elastomer composition for operating temperature range from -30 degrees F (-34 degrees C) to 230 degrees F (110 degrees C).
 3. Accessories: Steel bolts, nuts, and washers.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
1. CADDY; nVent.
 2. Carpenter & Paterson, Inc.
 3. Empire Industries, Inc.
 4. Globe Pipe Hanger Products Incorporated.
 5. Haydon Corporation.
 6. Hilti, Inc.
 7. NIBCO INC.
 8. PHD Manufacturing, Inc.
 9. PHS Industries, Inc.
 10. Unitron Product, Inc. / US-Strut.
- B. Substitutions: Section 01 60 00 - Product Requirements.
- C. Conform to ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 40 mm): Malleable iron, adjustable swivel, split ring.
- E. Hangers for Cold Pipe Sizes 2 inches (50 mm) and Larger: Carbon steel, adjustable, clevis.
- F. Hangers for Hot Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.

- G. Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Adjustable steel yoke, cast iron roll, double hanger.
- H. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- I. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
- J. Wall Support for Pipe Sizes 3 inches (76 mm) and Smaller: Cast iron hooks.
- K. Wall Support for Pipe Sizes 4 inches (100 mm) and Larger: Welded steel bracket and wrought steel clamp.
- L. Wall Support for Hot Pipe Sizes 6 inches (150 mm) and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- M. Vertical Support: Steel riser clamp.
- N. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- O. Floor Support for Hot Pipe 4 inches (100 mm) and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- P. Floor Support for Hot Pipe Sizes 6 inches (150 mm) and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- Q. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- R. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- S. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- T. Sheet Lead: ASTM B749, 2.5 lb/sq. ft., 0.039 inch (0.99 mm) thick.

2.4 VALVES

- A. Manufacturers:
 - 1. Emerson Climate Technologies; Emerson Electric Co.
 - 2. Mueller Co.
 - 3. Parker Hannifin Corp.

- B. Substitutions: Section 01 60 00 - Product Requirements.
- C. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet solder or flared ends.
 - 2. Phosphor bronze and stainless steel diaphragms, rising stem and hand wheel.
 - 3. Stainless steel spring, nylon seats, disc with positive back seating.
 - 4. Maximum working pressure: 500 psig (3450 kPa).
 - 5. Maximum working temperature: 275 degrees F (135 degrees C).
- D. Packed Angle Valves:
 - 1. Forged brass, solder or flared ends.
 - 2. Forged brass seal caps with copper gasket, rising stem and seat, molded stem packing.
 - 3. Maximum working pressure: 500 psig (3450 kPa).
 - 4. Maximum working temperature: 275 degrees F (135 degrees C).
- E. Ball Valves:
 - 1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals, ends.
 - 2. Maximum working pressure: 500 psig (3450 kPa).
 - 3. Maximum working temperature: 325 degrees F (163 degrees C).
- F. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, flared or solder ends.
 - 2. Maximum working pressure: 500 psig (3450 kPa).
- G. Refrigerant Check Valves:
 - 1. Manufacturers:
 - a. Danfoss Inc.
 - b. Mueller Co.
 - c. Parker Hannifin Corp.
 - 2. Substitutions: Section 01 60 00 - Product Requirements.
 - 3. Straight Through Type:
 - a. Spring, neoprene seat.
 - b. Maximum working pressure: 500 psig (3450 kPa).
 - c. Maximum working temperature: 250 degrees F (121 degrees C).

2.5 REFRIGERANT STRAINERS

- A. Manufacturers:
 - 1. Danfoss Inc.

2. Parker Hannifin Corp.
- B. Substitutions: Section 01 60 00 - Product Requirements.
- C. Straight Line or Angle Line Type:
 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass.
 2. Maximum working pressure: 430 psig (2960 kPa).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches (100 mm) and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.5, ASTM F708, and MSS SP 89.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
- D. Place hangers within 12 inches (300 mm) of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping.
- I. Prime coat exposed steel hangers and supports in accordance with Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- K. Install pipe hangers and supports in accordance with Section 23 05 29.

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- E. Install pipe identification in accordance with Section 23 05 53.

- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 - G. Provide access where valves and fittings are not exposed.
 - H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
 - I. Flood refrigerant piping system with nitrogen when brazing.
 - J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.
 - K. Install valves with stems upright or horizontal, not inverted.
 - L. Insulate piping; refer to Section 23 07 00.
 - M. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.
 - N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
 - O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
 - P. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
 - Q. Provide electrical connection to solenoid valves. Refer to Section 26 05 03.
 - R. Fully charge completed system with refrigerant after testing.
 - S. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
 - T. Install refrigerant piping in accordance with ASME B31.5.
- 3.6 INSTALLATION - REFRIGERANT SPECIALTIES
- A. Refrigerant Liquid Indicators:
 1. Install line size liquid indicators in main liquid line downstream of condenser.
 2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
 3. Install line size liquid indicators downstream of liquid solenoid valves.

- B. Refrigerant Valves:
 - 1. Install service valves on compressor suction and discharge.
 - 2. Install gage taps at compressor inlet and outlet.
 - 3. Install gage taps at hot gas bypass regulators, inlet and outlet.
 - 4. Install check valves on compressor discharge.
 - 5. Install check valves on condenser liquid lines on multiple condenser systems.
 - 6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

- C. Strainers:
 - 1. Install line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
 - 3. On steel piping systems, install strainer in suction line.
 - 4. Install shut-off valves on each side of strainer.

- D. Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test refrigeration system with dry nitrogen to 200 psig (1470 kPa).
- D. Repair leaks.
- E. Retest until no leaks are detected.

3.8 SCHEDULES

- A. Copper Tube Hanger Spacing:
 - 1. Pipe Size 1/2 Inch (12 mm):
 - a. Maximum Hanger Spacing: 5 feet (1.5 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 - 2. Pipe Size 3/4 Inch (20 mm):
 - a. Maximum Hanger Spacing: 5 feet (1.5 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 - 3. Pipe Size 1 Inch (25 mm):
 - a. Maximum Hanger Spacing: 6 feet (1.8 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).

4. Pipe Size 1-1/4 Inches (32 mm):
 - a. Maximum Hanger Spacing: 7 feet (2.1 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 5. Pipe Size 1-1/2 Inches (38 mm):
 - a. Maximum Hanger Spacing: 8 feet (2.4 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 6. Pipe Size 2 Inches (50 mm):
 - a. Maximum Hanger Spacing: 8 feet (2.4 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 7. Pipe Size 2-1/2 Inches (65 mm):
 - a. Maximum Hanger Spacing: 9 feet (2.7 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
 8. Pipe Size 3 Inches (75 mm):
 - a. Maximum Hanger Spacing: 10 feet (3 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
 9. Pipe Size 4 Inches (100 mm):
 - a. Maximum Hanger Spacing: 10 feet (3 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
 10. Pipe Size 5 Inches (125 mm):
 - a. Maximum Hanger Spacing: 10 feet (3 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
 11. Pipe Size 6 Inches (150 mm):
 - a. Maximum Hanger Spacing: 10 feet (3 m).
 - b. Hanger Rod Diameter: 5/8 inch (15 mm).
- B. Steel Pipe Hanger Spacing:
1. Pipe Size 1/2 Inch (12 mm):
 - a. Maximum Hanger Spacing: 7 feet (2.1 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 2. Pipe Size 3/4 Inch (20 mm):
 - a. Maximum Hanger Spacing: 7 feet (2.1 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 3. Pipe Size 1 Inch (25 mm):
 - a. Maximum Hanger Spacing: 7 feet (2.1 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 4. Pipe Size 1-1/4 Inches (32 mm):
 - a. Maximum Hanger Spacing: 7 feet (2.1 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 5. Pipe Size 1-1/2 Inches (38 mm):
 - a. Maximum Hanger Spacing: 9 feet (2.7 m).
 - b. Hanger Rod Diameter: 3/8 inch (9 mm).
 6. Pipe Size 2 Inches (50 mm):

- a. Maximum Hanger Spacing: 10 feet (3 m).
- b. Hanger Rod Diameter: 3/8 inch (9 mm).
7. Pipe Size 2-1/2 Inches (65 mm):
 - a. Maximum Hanger Spacing: 11 feet (3.4 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
8. Pipe Size 3 Inches (75 mm):
 - a. Maximum Hanger Spacing: 12 feet (3.7 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
9. Pipe Size 4 Inches (100 mm):
 - a. Maximum Hanger Spacing: 12 feet (3.7 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
10. Pipe Size 5 Inches (125 mm):
 - a. Maximum Hanger Spacing: 12 feet (3.7 m).
 - b. Hanger Rod Diameter: 1/2 inch (12 mm).
11. Pipe Size 6 Inches (150 mm):
 - a. Maximum Hanger Spacing: 12 feet (3.7 m).
 - b. Hanger Rod Diameter: 5/8 inch (15 mm).

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SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duct materials.
2. Flexible ducts.
3. Insulated flexible ducts.
4. Single-wall, spiral round ducts.
5. Single-wall, spiral flat oval ducts.
6. Ductwork fabrication.

B. Related Requirements:

1. Section 03 30 00 - Cast-in-Place Concrete: Requirements for concrete curbs as specified in this Section.
2. Section 09 90 00 - Painting and Coating: Requirements for painting or coating as specified in this Section.
3. Section 11 40 00 - Foodservice Equipment: Requirements for kitchen range hoods for placement by this Section.
4. Section 23 33 00 - Air Duct Accessories: Requirements for duct accessories as specified in this Section.

1.2 REFERENCE STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE Handbook - Fundamentals.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.1M - Structural Welding Code - Steel.
3. AWS D1.2 - Structural Welding Code - Aluminum.
4. AWS D1.2M - Structural Welding Code - Aluminum.
5. AWS D9.1 - Sheet Metal Welding Code.
6. AWS D9.1M - Sheet Metal Welding Code.

C. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A36M - Standard Specification for Carbon Structural Steel.
3. ASTM A90 - Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

4. ASTM A90M - Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
5. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
6. ASTM A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
7. ASTM A568 - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
8. ASTM A568M - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
9. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
11. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
12. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
13. ASTM A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
14. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
15. ASTM A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
16. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
17. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
18. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
19. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).
20. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
21. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).

22. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. International Code Council:

1. International Energy Conservation Code (IECC).
2. International Mechanical Code (IMC).

E. NFPA:

1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

F. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA 016 - HVAC Air Duct Leakage Test Manual.
2. SMACNA 1767 - Kitchen Ventilation Systems and Food Service Equipment Guidelines.
3. SMACNA 1884 - Fibrous Glass Duct Construction Standards.
4. SMACNA 1966 - HVAC Duct Construction Standards - Metal and Flexible.

G. UL:

1. UL 181 - Factory-Made Air Ducts and Air Connectors.
2. UL 181A - Closure Systems for Use With Rigid Air Ducts.
3. UL 1978 - Grease Ducts.

1.3 PREINSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for duct materials, duct liner, duct connectors.

C. Shop Drawings:

1. Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch (mm) equals 1 foot (1 m), on sheets same size as Contract Drawings, indicating following:
 - a. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other Work.
 - b. Duct layout that further indicates pressure classifications and sizes in plan view; exhaust duct systems that further indicate classification of materials handled as specified in this Section.
 - c. Fittings.
 - d. Reinforcing details and spacing.
 - e. Seam and joint construction details.
 - f. Penetrations through fire-rated and other walls.
 - g. Terminal unit, coil, and humidifier installations.
 - h. Hangers and supports, including methods for vibration isolation and building and duct attachment.
- D. Samples: Submit two typical shop-fabricated duct fittings.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.
- G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for following:
 1. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
 2. Materials, fabrication, assembly, and spacing of hangers and supports.
 3. Sheet metal thicknesses.
 4. Joint and seam construction and sealing.
 5. Reinforcement details and spacing.
- H. Test and Evaluation Reports: Indicate pressure tests performed, including date, section tested, test pressure, and leakage rate according to SMACNA 016.
- I. Manufacturer Instructions:
 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
 2. Submit special procedures for glass-fiber ducts.
- J. Qualifications Statements:
 1. Submit qualifications for manufacturer, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.

3. Welders: Qualify procedures and personnel according to AWS D1.1 (D1.1M) for hangers and supports, AWS D1.2 (D1.2M) for aluminum supports, and AWS D9.1 (D9.1M) for duct joint and seam welding.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents:
 1. Record actual locations of ducts and duct fittings.
 2. Record changes in fitting location and type.
 3. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Perform Work according to SMACNA 1884 and 1966.
- B. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standard standards.
- C. Maintain copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
- C. Welders: AWS qualified within previous 12 months for employed weld types.
- D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed at Project location.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

- A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions: Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.
- C. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.

1.10 EXISTING CONDITIONS

- A. Field Measurements:
 1. Verify field measurements prior to fabrication.
 2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for ducts.

PART 2 - PRODUCTS

2.1 DUCTS

- A. Performance and Design Criteria:
 1. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission of Architect/Engineer.
 2. Size round ducts installed in place of rectangular ducts according to ASHRAE Handbook - Fundamentals.
- B. Materials:
- C. Galvanized-Steel Ducts:
 1. Material: ASTM A653 (A653M) galvanized-steel sheet.
 2. Quality: Lock forming.
 3. Finish: G60 (Z180) zinc coating according to ASTM A90 (A90M).

- D. Steel Ducts: Comply with ASTM A1008 (A1008M).
- E. Aluminum Ducts:
 - 1. Material: ASTM B209 (B209M) aluminum sheet Alloy 3003-H14.
 - 2. Connectors and Bar Stock: Aluminum Alloy 6061-T6 or equivalent strength.
- F. Stainless-Steel Ducts: Comply with ASTM A240 (A240M), Type 316.
- G. Concrete Ducts:
 - 1. Description: Hub-and-spigot concrete sewer pipe with ASTM C443 (C443M) joints and rubber gaskets.
 - 2. Comply with ASTM C14 (C14M).
- H. Fasteners: Rivets, bolts, or sheet metal screws.
- I. Hanger Rod:
 - 1. Material: Galvanized steel.
 - 2. Comply with ASTM A36 (A36M).
 - 3. Type: Threaded both ends.

2.2 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Hart & Cooley Inc.
 - 2. Substitutions: As specified in Section 01 60 00 - Product Requirements.
- B. Description:
 - 1. Two-ply vinyl film supported by helical-wound spring steel wire.
 - 2. Pressure Rating: 10-inch wg (2.50 kPa) positive and 1.0-inch wg (250 Pa) negative.
 - 3. Maximum Velocity: 4,000 fpm (20.3 m/s).
 - 4. Temperature Range: Minus 10 to plus 160 degrees F (Minus 23 to plus 71 degrees C).
- C. Description:
 - 1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
 - 2. Pressure Rating: 10-inch wg (2.50 kPa) positive and 1.0-inch wg (250 Pa) negative.
 - 3. Maximum Velocity: 4,000 fpm (20.3 m/s).
 - 4. Temperature Range: Minus 20 to plus 210 degrees F (Minus 28 to plus 99 degrees C).

2.3 INSULATED FLEXIBLE DUCTS

- A. Manufacturers:

1. MasterFlow; GAF.
2. Thermaflex; a Flex-Tek Group company.
3. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:

1. Two-ply vinyl film supported by helical-wound spring steel wire.
2. Insulation: Fiberglass.
3. Vapor Barrier Film: Aluminized.
4. Pressure Rating: 10-inch wg (2.50 kPa) positive and 1.0-inch wg (250 Pa) negative.
5. Maximum Velocity: 4,000 fpm (20.3 m/s).
6. Temperature Range: Minus 10 to plus 160 degrees F (Minus 23 to plus 71 degrees C).
7. Thermal Resistance: 2.4 sq. ft. x h x deg. F/Btu.

C. Description:

1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
2. Insulation: Fiberglass.
3. Vapor Barrier Film: Aluminized.
4. Pressure Rating: 10-inch wg (2.50 kPa) positive and 1.0-inch wg (250 Pa) negative.
5. Maximum Velocity: 4,000 fpm (20.3 m/s).
6. Temperature Range: Minus 20 to plus 210 degrees F (Minus 28 to plus 99 degrees C).
7. Thermal Resistance: 2.4 sq. ft. x h x deg. F/Btu.

2.4 SINGLE-WALL, SPIRAL ROUND DUCTS

A. Manufacturers:

1. McGill AirFlow LLC.
2. Spiro Metal Inc.
3. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:

1. UL 181, Class 1, round spiral lockseam duct.
2. Material: Galvanized steel.

C. Minimum Duct Wall Thicknesses:

1. Diameter 2 to 14 Inches (50 to 350 mm): 26 gage (0.5 mm).
2. Diameter 16 to 26 Inches (400 to 650 mm): 24 gage (0.6 mm).
3. Diameter 28 to 36 Inches (700 to 900 mm): 22 gage (0.7 mm).
4. Diameter 38 to 50 Inches (950 to 1 250 mm): 20 gage (0.9 mm).
5. Diameter 52 to 60 Inches (1 300 to 1 500 mm): 18 gage (1.2 mm).

D. Minimum Fittings Wall Thicknesses:

1. Diameter 2 to 14 Inches (50 to 350 mm): 24 gage (0.6 mm).
2. Diameter 16 to 26 Inches (400 to 650 mm): 22 gage (0.7 mm).
3. Diameter 28 to 36 Inches (700 to 900 mm): 20 gage (0.9 mm).
4. Diameter 38 to 50 Inches (950 to 1 250 mm): 20 gage (0.9 mm).
5. Diameter 52 to 60 Inches (1 300 to 1 500 mm): 18 gage (1.2 mm).

2.5 SINGLE-WALL, SPIRAL FLAT OVAL DUCTS

A. Manufacturers:

1. McGill AirFlow LLC.
2. Spiro Metal Inc.
3. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:

1. Machine made from round spiral lockseam duct.
2. Material: Galvanized steel.
3. Pressure Rating: 10-inch wg (2.5 kPa).

C. Joints:

1. Type: Fully welded or bolted flange.
2. Gasket Material: As recommended by manufacturer.

D. Minimum Duct Wall Thicknesses:

1. Major Axis Dimension 7 to 24 Inches (178 to 610 mm): 24 gage (0.6 mm).
2. Major Axis Dimension 25 to 48 Inches (635 to 1 220 mm): 22 gage (0.7 mm).
3. Major Axis Dimension 50 to 70 Inches (1 270 to 1 780 mm): 20 gage (0.9 mm).
4. Major Axis Dimension 72 to 82 Inches (1 830 to 2 080 mm): 18 gage (1.2 mm).
5. Major Axis Dimension 84 Inches (2 130 mm) and Larger: 16 gage (1.5 mm).

E. Minimum Fittings Wall Thicknesses:

1. Major Axis Dimension 7 to 36 Inches (178 to 914 mm): 20 gage (0.9 mm).
2. Major Axis Dimension 37 to 60 Inches (940 to 1 520 mm): 18 gage (1.2 mm).
3. Major Axis Dimension 62 Inches (1 580 mm) and Larger: 16 gage (1.5 mm).

2.6 FABRICATION

A. Rectangular Ducts:

1. According to SMACNA 1966 and as indicated on Drawings.
2. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

B. Round Ducts:

1. According to SMACNA 1966 and as indicated on Drawings.

2. Seams: Longitudinal.
 3. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.
- C. Tees, Bends, and Elbows:
1. Minimum Radius:
 - a. 1-1/2 times centerline duct width.
 - b. If not possible or if rectangular elbows are used, provide airfoil turning vanes.
 2. If acoustical lining is indicated, furnish turning vanes of perforated metal with glass-fiber insulation.
- D. Divergence:
1. Increase duct sizes gradually, not exceeding 15 degrees of divergence wherever possible.
 2. Upstream of Equipment: Maximum 30 degrees.
 3. Downstream of Equipment: Maximum 45 degrees.
- E. Welding:
1. Continuously Welded Round and Oval Duct Fittings: Two gages heavier than duct gages according to SMACNA 1966.
 2. Cemented Slip Joints:
 - a. Minimum 4 inches (100 mm).
 - b. Brazed or electric welded.
 3. Prime coat welded joints.
- F. Takeoffs:
1. Provide standard 45-degree lateral wye takeoffs.
 2. If not possible due to space limitations, provide 90-degree conical tee connections.
- G. Sealing:
1. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
 2. Sealants, Mastics, and Tapes: Comply with UL 181A and provide products bearing appropriate UL 181A markings.
- ## 2.7 ACCESSORIES
- A. Hangers and Supports:
1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
3. Strap and Rod Sizes:
 - a. Comply with SMACNA 1966.
 - b. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.
4. Trapeze and Riser Supports:
 - a. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - b. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - c. Supports for Aluminum Ducts: Aluminum or galvanized steel, coated with zinc chromate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify sizes of equipment connections before fabricating transitions.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
- C. Install temporary closures of metal or taped PE on open ductwork to prevent construction dust from entering ductwork system.

3.3 INSTALLATION

- A. Install and seal ducts according to SMACNA 1966.
- B. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.
- C. Insulated Flexible Duct Fittings:
 1. Join each flexible duct section to main trunk duct through sheet metal fittings.
 2. Material: Galvanized steel.
 3. Equip fittings with factory-installed volume damper having positive locking regulator.
 4. Provide insulation guard with fittings installed in lined ductwork.

- D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches (200 mm) and smaller.

- E. Hanger and Supports:
 - 1. Fabricate and support ducts according to SMACNA 1966.
 - 2. Threaded Rods: Provide double nuts and lock washers.
 - 3. Building Attachments:
 - a. Provide concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - b. If possible, install concrete inserts before placing concrete.
 - c. Powder-Actuated Concrete Fasteners:
 - 1) Use only for slabs more than 4 inches (102 mm) thick.
 - 2) Install after concrete is placed and completely cured.
 - 3) Do not use powder-actuated concrete fasteners for seismic restraints.
 - 4. Hanger Spacing:
 - a. Comply with SMACNA 1966.
 - b. Install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1.2 m) of each branch intersection.
 - c. Extend strap supports down both sides of ducts and turn under bottom at least 1 inch (25 mm).
 - d. Secure hanger to sides and bottom of ducts with sheet metal screws.
 - 5. Hangers Exposed to View: Provide threaded rod and angle or channel supports.
 - 6. Vertical Ducts:
 - a. Support with steel angles or channel secured to sides of duct with welds, bolts, sheet metal screws, or blind rivets.
 - b. Support at each floor and at maximum intervals of 16 feet (4.9 m).
 - 7. Upper Attachments:
 - a. Attach to structures.
 - b. Selection and Sizing: Provide pull-out, tension, and shear capacities as required for supported loads and building materials.
 - 8. Penetrations:
 - a. Avoid penetrations of ducts with hanger rods.
 - b. If unavoidable, provide airtight rubber grommets at penetrations.

- F. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

- G. Plenum Doors:
 - 1. Location: 6 to 12 inches (150 to 300 mm) above floor.
 - 2. Arrange door swing such that fan static pressure holds door in closed position.

- H. Outdoor Ductwork: Protect ductwork and ductwork supports, linings, and coverings from weather.

- I. Exhaust Outlet Locations:
 - 1. Minimum Distance from Property Lines: 30 feet (9140 mm).
 - 2. Minimum Distance from Building Openings: 3 feet (914 mm).
 - 3. Minimum Distance from Outside Air Intakes: 10 feet (3 048 mm).

- J. Interface with Other Work:
 - 1. Install openings in ductwork as required to accommodate thermometers and controllers.
 - 2. Install pitot tube openings for testing of systems, complete with metal can with spring device or screw to prevent air leakage.
 - 3. If openings are provided in insulated ductwork, install insulation material inside metal ring.
 - 4. Connect diffusers to low-pressure ducts with 5-foot (1.5-m) maximum length of flexible duct held in place with strap or clamp.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

- B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

- C. Testing:
 - 1. Ductwork Designed for 3-Inch wg (750 Pa) above Ambient Pressure:
 - a. Pressure test minimum 25 percent of ductwork after duct cleaning but before duct insulation is applied or ductwork is concealed.
 - b. Comply with SMACNA 016.
 - c. Maximum Allowable Leakage: According to IECC.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

- B. Clean duct system and force air at high velocity through duct to remove accumulated dust.

- C. To obtain sufficient airflow, clean one half of system completely before proceeding to other half.

- D. Vacuuming:
 - 1. Clean duct systems with high-power vacuum machines.
 - 2. Install access openings into ductwork for cleaning purposes.

- E. Protect sensitive equipment with temporary filters or bypass during cleaning.

3.6 ATTACHMENTS

- A. Ductwork Material Schedule:
 - 1. Supply - Systems with Cooling/Heating Coils: Steel, aluminum, or fibrous glass.
 - 2. Return and Relief : Steel or aluminum.
 - 3. General Exhaust: Steel or aluminum.
 - 4. Outside Air Intake: Steel.
 - 5. Intake and Exhaust: Steel.

- B. Ductwork Pressure Class Schedule:
 - 1. Supply and Exhaust: 1-inch wg (250 kPa), regardless of velocity.
 - 2. Return and Relief: 1/2-inch wg (125 Pa).

END OF SECTION 23 31 00

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Combination fire-and-smoke dampers.
3. Duct access doors.
4. Volume control dampers.
5. Flexible duct connections.
6. Duct test holes.
7. Dial thermometers.
8. Static pressure gages.

B. Related Sections:

1. Section 23 09 00 - Instrumentation and Control for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
2. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
3. Section 23 09 53 - Pneumatic and Electric Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
4. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 2. NFPA 92A - Recommended Practice for Smoke-Control Systems.
- D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- E. Underwriters Laboratories Inc.:
1. UL 555 - Standard for Safety for Fire Dampers.
 2. UL 555C - Standard for Safety for Ceiling Dampers.
 3. UL 555S - Standard for Safety for Smoke Dampers.
- 1.3 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.
- C. Product Data: Submit data for shop fabricated assemblies and hardware used.
- D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
1. Fire dampers including locations and ratings.
 2. Smoke dampers including locations and ratings.
 3. Backdraft dampers.
 4. Flexible duct connections.
 5. Volume control dampers.
 6. Duct access doors.
 7. Duct test holes.
- E. Product Data: For combination fire and smoke dampers submit the following:
1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
 2. Indicate materials, construction, dimensions, and installation details.
 3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- F. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of volume dampers and access doors.
- C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.5 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- C. Perform Work in accordance with State of California Public Work's standard.
- D. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work where appropriate with building control Work.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for duct accessories.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.1 BACK-DRAFT DAMPERS

- A. Manufacturers:
 - 1. Carnes Company.
 - 2. FAMCO.
 - 3. Greenheck Fan Corporation.
 - 4. Ruskin Company.
 - 5. TAMCO (T. A. Morrison & Co. Inc.).
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage (1.5 mm) thick steel, or extruded aluminum. Blades, maximum 6 inch (150 mm) width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:

1. Carnes Company.
 2. Cesco Products; a division of MESTEK, Inc.
 3. Greenheck Fan Corporation.
 4. Lloyd Industries, Inc.
 5. Nailor Industries Inc.
 6. Ruskin Company.
 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.
- C. Fire Resistance: 1-1/2 hours.
- D. Leakage Rating: Class I, maximum of 8 cfm (3.8 L/s) at 4 inches wg (1 kPa) differential pressure.
- E. Damper Temperature Rating: 350 degrees F (176 degrees C).
- F. Frame: 16 gage (1.5 mm), galvanized steel.
- G. Blades:
1. Style: Single skin with 3 longitudinal grooves.
 2. Action: Opposed.
 3. Orientation: Horizontal.
 4. Material: Minimum 16 gage (1.5 mm) equivalent thickness, galvanized steel.
 5. Width: Maximum 6 inches (150 mm).
- H. Bearings: Stainless steel pressed into frame.
- I. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.
- J. Linkage: Concealed in frame.
- K. Release Device: Close in controlled manner and lock damper through actuator closure spring.
- L. Actuator:
1. Type: Electric 120 volt, 60 hertz, two-position, fail close.
 2. Mounting: External.
- M. Finish: Mill galvanized.
- N. Factory installed sleeve and mounting angles. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

2.3 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. ACUDOR Products, Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Duro Dyne Inc.
 - 4. Kees, Inc.
 - 5. Lane-Aire Manufacturing Corp.
 - 6. McGill AirFlow LLC.
 - 7. Nailor Industries Inc.
 - 8. Nelson Industrial Inc.
 - 9. Ruskin Company.
 - 10. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch (25 mm) thick insulation with sheet metal cover.
 - 1. Less than 12 inches (300 mm) square, secure with sash locks.
 - 2. Up to 18 inches (450 mm) Square: Furnish two hinges and two sash locks.
 - 3. Up to 24 x 48 inches (600 x 1200 mm): Three hinges and two compression latches.
 - 4. Larger Sizes: Furnish additional hinge.
 - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.4 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Air Balance; a division of MESTEK, Inc.
 - 2. Carnes Company.
 - 3. McGill AirFlow LLC.
 - 4. Nailor Industries Inc.
 - 5. Ruskin Company.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- C. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches (600 mm) size in both dimensions, and two gages heavier for sizes over 24 inches (600 mm).

2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.
 4. Single Blade Dampers: Fabricate for duct sizes up to 12 x 48 inch (300 x 1220 mm).
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- E. End Bearings: Except in round ductwork 12 inches (300 mm) and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg (500 Pa).
- F. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
 3. Where rod lengths exceed 30 inches (750 mm) furnish regulator at both ends.

2.5 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturers:
1. Duro Dyne Inc.
 2. Flexmaster U.S.A., Inc.
 3. Hart & Cooley Inc.
 4. Labconco Corporation.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- C. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd (1.0 kg/sq m).
 2. Net Fabric Width: Approximately 2 inches (50 mm) wide.
 3. Metal: 3 inch (75 mm) wide, 24 gage (0.6 mm thick) galvanized steel.
- D. Leaded Vinyl Sheet: Minimum 0.55 inch (14 mm) thick, 0.87 lbs. per sq ft (4.2 kg/sq m), 10 dB attenuation in 10 to 10,000 Hz range.

2.6 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.7 DIAL THERMOMETERS

- A. Manufacturers:
 - 1. Ashcroft Inc.
 - 2. MEPCO (Marshall Engineered Products Co.).
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Thermometer: ASTM E1, stainless steel case, adjustable angle with front calibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3 inch (76 mm) diameter dial.
 - 2. Lens: Clear glass.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F.

2.8 STATIC PRESSURE GAGES

- A. Manufacturers:
 - 1. Ashcroft Inc.
 - 2. Dwyer Instruments, Inc.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Dial Gages: dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.
- C. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify rated walls are ready for fire damper installation.

- C. Verify ducts and equipment installation are ready for accessories.
- D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.
- C. Access Doors: Install access doors at the following locations and as indicated on Drawings:
 - 1. Spaced every 50 feet (15 m) of straight duct.
 - 2. At each combination fire and smoke damper.
- D. Access Door Sizes: Install minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.
 - 1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.
- E. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- F. Install combination fire and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
 - 1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
 - 2. Install dampers square and free from racking with blades running horizontally.
 - 3. Do not compress or stretch damper frame into duct or opening.
 - 4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
 - 5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.3 INSTALLATION - THERMOMETERS

- A. Install thermometers in air duct systems on flanges.
- B. Where thermometers are provided on local panels, duct mounted thermometers are not required.
- C. Locate duct-mounted thermometers minimum 10 feet (3 m) downstream of mixing-dampers, coils, or other devices causing air turbulence.
- D. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.
- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- F. Install thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Adjust thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.4 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate re-setting of fire dampers to Owner's representative.

3.5 SCHEDULES

- A. Dial Thermometer Location:
 - 1. Each supply air zone.
 - 2. Outside air.
 - 3. Return air.
 - 4. Mixed air.
- B. Static Pressure and Filter Gages:
 - 1. Built up filter banks.
 - a. Location:
 - b. Scale range:
 - 2. Supply fan discharge.
 - a. Location:
 - b. Scale range:
 - 3. Building static.

- a. Location:
- b. Scale range:

END OF SECTION 23 33 00

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SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal filtered supply fans.
2. Downblast centrifugal roof fans.
3. Ceiling fans.
4. Centrifugal square inline fans.
5. Roof ventilators.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
4. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
5. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
6. Section 23 09 53 - Pneumatic and Electric Control System for HVAC: Product requirements for pneumatic control components to interface with fans.
7. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
8. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
9. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.

2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. American Refrigeration Institute:
1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
- D. ASTM International:
1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
- E. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.
 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. Underwriters Laboratories Inc.:
1. UL 705 - Power Ventilators.
- 1.3 PERFORMANCE REQUIREMENTS
- A. Wind-Borne Debris Loads: Design louvers located within 30 feet (9.144 m) of grade to withstand ASTM E1996; large missile impact test.
- 1.4 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.
- E. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for fans.

1.12 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of fans for one years from Date of Substantial Completion.
- C. Examine each fan components bi-monthly. Clean, adjust, and lubricate equipment.
- D. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- E. Perform work without removing fans from service during building normal occupied hours.
- F. Provide emergency call back service at all hours for this maintenance period.
- G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- H. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of belts for each fan.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL FILTERED SUPPLY FANS

A. Manufacturers:

1. Acme Engineering & Manufacturing Corp.
2. Aerovent; a division of Twin City Fan Companies, Ltd.
3. Central Blower Company.
4. Chicago Blower Corporation.
5. Cincinnati Fan.
6. CML Northern Blower Inc.
7. Greenheck Fan Corporation.
8. Howden.
9. Loren Cook Company.
10. New York Blower Company (The).
11. PennBarry.
12. Substitutions: Section 01 60 00 - Product Requirements.

B. Performance:

1. Performance Base: Sea level conditions.
2. Temperature Limit: Maximum 300 degrees F (150 degrees C).
3. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

C. Wheel and Inlet:

1. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, back plate, backward curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

D. Housing:

1. Steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
2. Bolted construction with horizontal flanged split housing.
3. Fabricate plug fans without volute housing, in lined steel cabinet.

E. Bearings and Sleeves:

1. Bearings: Pillow block type, self-aligning, grease-lubricated roller bearings, or ABMA 11, L-50 life at 400,000 hours.
2. Shafts: Hot rolled steel, ground and polished, with key way, protectively coated with lubricating oil, and shaft guard.

3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 kW) and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp (15 kW) and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
4. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch (2.6 mm) thick, 3/4 inch (20 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

F. Accessories:

1. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
2. Adjustable Inlet Vanes: Steel construction with blades with two permanently lubricated bearings, variable mechanism terminating in single control lever with control shaft for double width fans and locking quadrant.
3. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
4. Scroll Drain: 1/2 inch (13 mm) steel pipe coupling welded to low point of fan scroll.
5. Gravity operated backdraft damper with spring return.
6. Motorized intake backdraft damper.
7. Intake Hood: Constructed of bolted, galvanized steel housing; insulated top cover, bottom skirt for attachment to roof curb, aluminum wire bird screen.

G. Filter: 4 inch (50 mm) thick MERV-13 filters with filter plenum box.

H. Electrical Characteristics and Components:

1. Electrical Characteristics: In accordance with Section 26 05 03 and as indicated on drawings.
2. Motors: In accordance with Section 23 05 13. Type: TEFC.
3. Disconnect Switch: Factory mount disconnect switch on equipment.

2.2 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:

1. Acme Engineering & Manufacturing Corp.
2. Fantech.
3. FloAire National.
4. Greenheck Fan Corporation.
5. Hartzell Fan Incorporated.
6. Loren Cook Company.

7. PennBarry.
 8. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fan Unit: Downblast type. direct drive, with spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Totally enclosed fan cooled.
- E. Roof Curb: 12 inch (300 mm) high self-flashing of aluminum construction with continuously welded seams, 1 inch (25 mm) insulation and curb bottom, hinged curb adapter, and factory installed nailer strip.
- F. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 250 Type 3R enclosure.
- G. Accessories:
1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
 2. Fan speed controller.

2.3 CEILING FANS

- A. Manufacturers:
1. Acme Engineering & Manufacturing Corp.
 2. Airmaster Fan Company.
 3. American Coolair Corporation.
 4. Fantech.
 5. Greenheck Fan Corporation.
 6. Loren Cook Company.
 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2 inch (13 mm) acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral outlet duct collar.
- C. Disconnect Switch: Fan mounted toggle switch for thermal overload protected motor.
- D. Grille: Molded white plastic.

- E. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.
- F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.
- G. Accessories:
 - 1. Eave elbow.
 - 2. Filter box.
 - 3. Brick vent constructed of extruded aluminum with inlet screen.
 - 4. Rubber-in-shear vibration isolator.
 - 5. Ceiling radiation damper.
 - 6. Fan speed controller.
 - 7. Time delay relay.

2.4 CENTRIFUGAL SQUARE INLINE FANS

- A. Manufacturers:
 - 1. Acme Engineering & Manufacturing Corp.
 - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
 - 3. American Coolair Corporation.
 - 4. Carnes Company.
 - 5. Fantech.
 - 6. Greenheck Fan Corporation.
 - 7. JencoFan.
 - 8. Loren Cook Company.
 - 9. Moffitt Corporation Inc.
 - 10. PennBarry.
 - 11. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Direct drive with galvanized steel housing, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.
- C. Fan Wheel: Backward inclined centrifugal type, aluminum construction.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- E. Motor and Drive Mounting: Out of air stream.
- F. Motor: Open drip proof.

- G. Bearings: ABMA 9 life at 200,000 hours.
- H. Accessories:
 - 1. Belt guard.
 - 2. Motor cover.
 - 3. Inlet safety screen.
 - 4. Outlet safety screen.
 - 5. Flexible duct connector.
 - 6. Filter box with throwaway type filter.
 - 7. Inlet Outlet ductwork companion flange.
 - 8. Fan speed controller.

2.5 GRAVITY ROOF VENTILATORS

- A. Manufacturers:
 - 1. American Coolair Corporation.
 - 2. Carnes Company.
 - 3. Cesco Products; a division of MESTEK, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. Loren Cook Company.
 - 6. Moffitt Corporation Inc.
 - 7. PennBarry.
 - 8. Western Canwell.
 - 9. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Square type, with aluminum housing; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Roof Curb: 12 inch (300 mm) high of galvanized steel construction with continuously welded seams, 1 inch (25 mm) insulation and curb bottom, and factory installed nailer strip.
- D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 PREPARATION

- A. Furnish roof curbs for installation.

3.3 INSTALLATION

- A. Secure roof fans and gravity ventilators with stainless steel lag screws to roof curb.
- B. Suspended Cabinet Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
- C. Install backdraft dampers on inlet to roof exhaust fans and gravity ventilators used in relief air applications.
- D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.
- E. Install safety screen where inlet or outlet is exposed.
- F. Pipe scroll drains to nearest floor drain.
- G. Install backdraft dampers on discharge of exhaust fans and as indicated on Drawings.
- H. Provide sheaves required for final air balance.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of fan cabinet.

3.6 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

- B. Demonstrate fan operation and maintenance procedures.

3.7 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 23 34 00

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SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
3. Grilles.
4. Louvers.

B. Related Sections:

1. Section 08 91 00 - Louvers: Wall Louvers.
2. Section 09 90 00 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
3. Section 23 09 00 - Instrumentation and Control for HVAC: Operators for adjustable louvers.
4. Section 23 09 23 - Direct-Digital Control System for HVAC: Operators for adjustable louvers.
5. Section 23 09 53 - Pneumatic and Electric Control System for HVAC: Operators for adjustable louvers.
6. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

- C. Samples: Submit two of each required air outlet and inlet type.
- D. Test Reports: Rating of air outlet and inlet performance.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.
- C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

1.7 MOCK-UP

- A. Section 01 40 00 - Quality Requirements: Mock-up requirements.
- B. Construct typical interior ceiling module with supply and return air outlets.
- C. Locate where directed by Architect/Engineer.
- D. Incorporate accepted mock-up as part of Work.
- E. Remove mock-up when directed by Architect/Engineer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer's warranty for air outlets and inlets.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish 10 percent extra air outlets and inlets.

PART 2 - PRODUCTS

2.1 RECTANGULAR CEILING DIFFUSERS

- A. Manufacturers:
 - 1. A-J Manufacturing Co., Inc.
 - 2. Anemostat Products; a Mestek company.
 - 3. Carnes Company.
 - 4. Hart & Cooley Inc.
 - 5. Kees, Inc.
 - 6. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 - 7. METALAIRE, Inc.
 - 8. Nailor Industries Inc.
 - 9. Price Industries.
 - 10. Titus; brand of Johnson Controls International plc, Global Products.
 - 11. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
 - 12. Substitutions: Section 01 60 00 - Product Requirements.
- B. Type: Square, adjustable pattern, stamped, multi-core diffuser to discharge air in four-way pattern with sector baffles where indicated.
- C. Frame: Surface mount, Snap-in type. In plaster ceilings, furnish plaster frame and ceiling frame.
- D. Fabrication: Aluminum with baked enamel off-white finish.
- E. Accessories: Radial opposed-blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.2 PERFORATED FACE CEILING DIFFUSERS

- A. Manufacturers:
1. Air Research Diffuser Products, Inc.
 2. A-J Manufacturing Co., Inc.
 3. Anemostat Products; a Mestek company.
 4. Carnes Company.
 5. Hart & Cooley Inc.
 6. Kees, Inc.
 7. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 8. METALAIRE, Inc.
 9. Nailor Industries Inc.
 10. Price Industries.
 11. Titus; brand of Johnson Controls International plc, Global Products.
 12. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
 13. Warren Technology.
 14. Substitutions: Section 01 60 00 - Product Requirements.
- B. Type: Perforated face with fully adjustable pattern and removable face.
- C. Frame: Snap-in type.
- D. Fabrication: Steel with aluminum frame and baked enamel off-white finish.
- E. Accessories: Multi-louvered equalizing grid with damper adjustable from diffuser face.

2.3 CEILING SUPPLY REGISTERS/GRILLES

- A. Manufacturers:
1. American Metal Products.
 2. Carnes Company.
 3. Hart & Cooley Inc.
 4. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 5. METALAIRE, Inc.
 6. Nailor Industries Inc.
 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
- C. Frame: 1-1/4 inch (32 mm) margin with concealed mounting and gasket.
- D. Fabrication: Aluminum extrusions with factory off-white enamel finish.

- E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Manufacturers:
 - 1. American Metal Products.
 - 2. Carnes Company.
 - 3. Dayus Register & Grille Inc.
 - 4. Hart & Cooley Inc.
 - 5. Kees, Inc.
 - 6. METALAIRE, Inc.
 - 7. Nailor Industries Inc.
 - 8. Titus; brand of Johnson Controls International plc, Global Products.
 - 9. Substitutions: Section 01 60 00 - Product Requirements.
- B. Type: Streamlined blades, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, horizontal face.
- C. Frame: 1-1/4 inch (32 mm) margin with concealed mounting.
- D. Fabrication: Steel with 20 gage (0.90 mm) minimum frames and 22 gage (0.80 mm) minimum blades, steel and aluminum with 20 gage (0.90 mm) minimum frame, or aluminum extrusions, with factory off-white enamel baked enamel finish.
- E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
- F. Gymnasiums: Furnish front pivoted or welded in place blades, securely fastened to be immobile.

2.5 WALL SUPPLY REGISTERS/GRILLES

- A. Manufacturers:
 - 1. American Metal Products.
 - 2. Carnes Company.
 - 3. Hart & Cooley Inc.
 - 4. Kees, Inc.
 - 5. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 - 6. METALAIRE, Inc.
 - 7. Reggio Register Company, Inc.
 - 8. Substitutions: Section 01 60 00 - Product Requirements.

- B. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, horizontal face, double deflection.
- C. Frame: 1-1/4 inch (32 mm) margin with concealed mounting and gasket.
- D. Fabrication: Steel with 20 gage (0.90 mm) minimum frames and 22 gage (0.80 mm) minimum blades, steel and aluminum with 20 gage (0.90 mm) minimum frame, or aluminum extrusions, with factory off-white enamel baked enamel finish.
- E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.
- F. Gymnasiums: Furnish front pivoted or welded in place blades, securely fastened to be immobile.

2.6 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Manufacturers:
 - 1. Hart & Cooley Inc.
 - 2. Reggio Register Company, Inc.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, horizontal face.
- C. Frame: 1-1/4 inch (32 mm) margin with concealed mounting.
- D. Fabrication: Aluminum extrusions, with factory off-white enamel baked enamel finish.
- E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.
- F. Gymnasiums: Furnish front pivoted or welded in place blades, securely fastened to be immobile.

2.7 LOUVERS

- A. Manufacturers:
 - 1. Air Louvers Inc.; a Division of the Activar Construction Products Group.
 - 2. Airolite Company, LLC (The).
 - 3. Ametco Manufacturing Corporation.
 - 4. Arrow United Industries.
 - 5. C/S Group.

6. Carnes Company.
7. Greenheck Fan Corporation.
8. Hart & Cooley Inc.
9. METALAIRE, Inc.
10. Nystrom.
11. Ruskin Company.
12. Substitutions: Section 01 60 00 - Product Requirements.

- B. Louvers: As specified in Section 08 91 00.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling, wall systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 90 00.
- D. Do not locate air registers, diffusers or grilles in floors of toilet or bathing rooms.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 23 37 00

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SECTION 23 40 00 - HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Disposable panel filters.
- B. Washable permanent panel filters.

1.2 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017.
- B. UL 586 - High Efficiency, Particulate, Air Filter Units Current Edition, Including All Revisions.
- C. UL 867 - Electrostatic Air Cleaners Current Edition, Including All Revisions.
- D. UL 900 - Standard for Air Filter Units Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

PART 2 - PRODUCTS

2.1 DISPOSABLE, EXTENDED AREA PANEL FILTERS

- A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
- B. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.

2.2 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, nonvolatile adhesive.
 - 1. Thickness: 1 inch (25 mm).
- B. Performance Rating:
 - 1. Face Velocity: 500 FPM (2.54 m/sec).
 - 2. Initial Resistance: 0.15 inch WG (37 Pa).
 - 3. Recommended Final Resistance: 0.50 inches WG (125 Pa).
- C. Casing: Cardboard frame.

2.3 WASHABLE PERMANENT PANEL FILTERS

- A. Media: 14 mesh steel screen, zinc electroplated, alternate layers of flat and herringbone crimp, four layers per inch (25 mm); rod reinforced.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION 23 40 00

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air handling unit.
2. Condensing unit.

B. Related Sections:

1. Section 03 30 00 - Cast-in-Place Concrete: Execution requirements for concrete foundations specified by this section.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC: Vibration isolators.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
5. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to hot water and drain piping specified by this section.
6. Section 23 22 13 - Steam and Condensate Heating Piping: Execution requirements for connection to steam supply and steam condensate return piping specified by this section.
7. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
8. Section 23 33 00 - Air Duct Accessories: Flexible connections.
9. Section 25 50 00 - Integrated Automation Facility Controls: Control systems remote from unit.
10. Section 26 05 83 - Wiring Connections: Electrical connection to units.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - C. ASTM International:
 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - D. National Electrical Manufacturers Association:
 1. NEMA MG 1 - Motors and Generators.
 - E. NFPA:
 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- 1.3 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
 - B. Product Data: Submit data indicating:
 1. Cooling and heating capacities.
 2. Dimensions.
 3. Weights.
 4. Rough-in connections and connection requirements.
 5. Duct connections.
 6. Electrical requirements with electrical characteristics and connection requirements.
 7. Controls.
 8. Accessories.
 - C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
 - D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - E. Manufacturer's Field Reports: Submit start-up report for each unit.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
 - B. Project Record Documents: Record actual locations of controls installed remotely from units.
 - C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

- A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.
- B. Cooling Capacity: Rate in accordance with ARI 210/240.
- C. Sound Rating: Measure in accordance with ARI 270.
- D. Insulation and adhesives: Meet requirements of NFPA 90A.
- E. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate installation of condensing units with concrete pad and structure.

C. Coordinate installation of air handling units with building structure.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for compressors.

1.11 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.

C. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within 24 hours.

1.12 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

PART 2 - PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Manufacturers:

1. Carrier Global Corporation.
2. Comfort-Aire; a division of Heat Controller, Inc.
3. Daikin Applied.
4. Lennox Industries, Inc.; Lennox International.
5. Luxaire; brand of Johnson Controls International plc, Building Solutions North America.
6. Rheem Manufacturing Company; Heating and Cooling Products.
7. Trane.
8. YORK; brand of Johnson Controls International plc, Building Solutions North America.

- B. Substitutions: As specified in Section 01 60 00 - Product Requirements.
- C. Product Description: Split system consisting of air handling unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.2 AIR HANDLING UNIT

- A. Configuration: As indicated on Drawings.
- B. Cabinet:
 - 1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
- C. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.
- D. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides.
- E. Refrigeration System: Single refrigeration circuits controlled by factory installed thermal expansion valve.
- F. Air Filters: 1-inch (25-mm)-thick glass fiber disposable media in metal frames.
- G. Air Handling Unit Accessories:
 - 1. Discharge Plenum: with construction and finish matching unit casing. Integral grille of aluminum construction and adjustable louvers.
 - 2. Return Air Grille: mounted in return air opening of aluminum construction and fixed louvers.
 - 3. Mounting Subbase with construction and finish matching unit casing.
 - 4. Vibration Isolators: Neoprene-in-shear type.

2.3 CONDENSING UNIT

- A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.
- B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with

removable panels for required access to compressors, controls, condenser fans, motors, and drives.

- C. Compressor: Single refrigeration circuit with rotary or hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.
- D. Condenser Coil: Constructed of copper tubing mechanically bonded to copper fins, factory leak and pressure tested.
- E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.
- F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection.
- G. Condensing Unit Accessories: Furnish the following accessories:
 - 1. Time delay relay.
 - 2. Anti-short cycle timer.
 - 3. Disconnect switch.
 - 4. Vibration isolators.
 - 5. Hot gas bypass kit.
 - 6. Coil with corrosion resistant coating capable of withstanding salt spray test of 1,000 hours in accordance with ASTM B117.
 - 7. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
 - 8. Suction and discharge pressure gauges.
- H. Refrigeration specialties: Furnish the following:
 - 1. Charge of compressor oil.
 - 2. Holding charge of refrigerant.
 - 3. Replaceable core type filter drier.
 - 4. Liquid line sight glass and moisture indicator.
 - 5. Shut-off valves on suction and liquid piping.
 - 6. Liquid line solenoid valve.
 - 7. Charging valve.
 - 8. Oil level sight glass.
 - 9. Crankcase heater.
 - 10. Hot gas muffler.
 - 11. Pressure relief device.

- I. Refrigerant: Furnish charge of refrigerant R-410A.

2.4 CONTROLS

- A. Thermostat: Seven-day programmable electronic space thermostat with two stage heating and two stage cooling with automatic changeover and heating setback and cooling setup capability. Furnish system selector switch and fan control switch, auto-on.
- B. Furnish interface to Building Automation and Control System specified in Section 23 09 23.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Section 26 05 83.
- B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT

3.3 Install air handling units on vibration isolators.

- A. Connect air handling units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.
- B. Install condensate piping with trap and route from drain pan to condensate drainage system.
- C. Install components furnished loose for field mounting.
- D. Install connection to electrical power wiring in accordance with Section 26 05 83.

3.4 INSTALLATION - CONDENSING UNIT

- A. Install condensing units on vibration isolators.

- B. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties specified in Section 23 23 00.
- C. Evacuate refrigerant piping and install initial charge of refrigerant.
- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between air handling unit, condensing unit, and field installed accessories.
- F. Install connection to electrical power wiring in accordance with Section 26 05 83.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.6 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install new throwaway filters in units at Substantial Completion.

3.7 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate air handling unit operation and maintenance.
- C. Demonstrate starting, maintenance, and operation of condensing unit.
- D. Furnish services of manufacturer's technical representative for one day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days' notice of training date.

3.8 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

- B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 23 81 26

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SECTION 23 81 29 - VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:
 - 1. Indoor units.
 - 2. Outdoor units.
 - 3. Heat recovery control units.
 - 4. System controls.

1.2 DEFINITIONS

- A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.
- B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.
- C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.
- D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- G. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or

multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

- H. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.
- I. VRF: Variable refrigerant flow.

1.3 PERFORMANCE REQUIREMENTS

- A. Wind Loads: Exterior condensing units, mounting assemblies and attachment to structure shall meet the wind structural loading requirements of the local Building Codes and Authorities Having Jurisdiction.
 - 1. Wind Design Pressures: As determined from wind speed, building category, wind exposure indicated on the structural drawings for specific equipment locations calculated per the structural wind loading requirements of the Building Code.
 - 2. Structural Attachment Forces: As determined from wind design pressures using actual equipment dimensions calculated per the structural wind loading requirements of the Building Code.
- B. Seismic Performance: VRF Systems, components and mounting assemblies shall withstand the effects of seismic forces in accord with project Seismic specifications.
- C. Service Access:
 - 1. Provide and document service access requirements.
 - 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
 - 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 - 4. If less than full and unrestricted access is provided, locate components within an 18-inch (450-mm) reach of the finished assembly.
 - 5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
 - 6. Comply with OSHA regulations.
- D. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
 2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
- E. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.
1. Each branch circuit shall accommodate addition of one indoor unit(s) with unit capacity equal to average indoor unit connected to the branch circuit.
 2. Each branch circuit shall accommodate deletion of one indoor unit(s) with unit capacity equal to average indoor unit connected to the branch circuit
- F. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.
- G. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
1. Not less than 50 percent.
 2. Not more than 130 percent.
 3. Range acceptable to manufacturer.
- H. System Turndown: Stable operation down to 15 percent of outdoor-unit capacity.
- I. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
- J. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
1. Indoor: Within design guidelines of "ASHRAE HANDBOOK- HVAC Applications."
 2. Outdoor: Within ordinance of governing authorities.
- K. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes
- 1.4 PREINSTALLATION MEETINGS
- A. Preinstallation Conference: Conduct conference at Project site.
- 1.5 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 indoor and outdoor units and for HRCUs, if applicable.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control, if applicable.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting and attachment 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. 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.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 - a. Retain copies of Installer certificates on-site and make available on request.
2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

- B. Wind compliance: Contractor's certification of compliance with wind structural loading requirements of the Building Code, wind loads identified in "Performance Requirement" article and Authority Having Jurisdiction. Submit as applicable:
 - 1. Product Approval: Equipment specific documentation indicating compliance.
 - 2. Delegated Design: Signed and sealed documents by registered engineer.
 - 3. Dimensioned Outline Drawings of Equipment: Identify maximum rated wind force in pounds per square foot, mounting and anchorage provisions.
 - 4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE7 special seismic certification as required. Include method used to determine compliance with requirements.
 - 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- D. Field quality-control reports.
- E. Sample Warranties: For manufacturer's warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

1.8 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. Filters:
 - a. One set(s) for each unit type and unique size of washable filters.

1.9 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of VRF systems and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. 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.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

- D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning"

- E. Manufacturer Qualifications:
 - 1. Nationally recognized manufacturer of VRF HVAC systems and products.
 - 2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
 - 3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
 - 4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
 - 5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing, and quality control.
 - d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
 - e. Owner training.

- F. Factory-Authorized Service Representative Qualifications:
 - 1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
 - 2. In-place facility located within 50 miles of Project.
 - 3. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
 - 4. Demonstrated past experience on five projects of similar complexity, scope, and value.
 - a. Each person assigned to Project shall have demonstrated past experience.
 - 5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
 - 6. Service and maintenance staff assigned to support Project during warranty period.
 - 7. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
 - 8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

- G. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.
 - 1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.
 - a. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
 - b. Demonstrated past experience on five projects of similar complexity, scope, and value.
5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.

H. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
 1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
 2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- E. Replace installed products damaged during construction.

1.11 DESIGN CRITERIA

- A. The air conditioning equipment Condensing Unit shall be specifically designed for mounting in an outdoor application: curb or pedestal mounting as indicated on the drawings. The VRF equipment and attachments to structure shall be designed to conform with the wind and seismic structural loading requirements identified in "Performance Requirement".
- B. All electrical components to be UL Listed.

- C. Total unit to be UL listed.
- D. All materials to meet requirements of NFPA 90A.
- E. Units shall have the configuration as indicated on the plans and/or as scheduled.
- F. Indoor units shall meet or exceed the scheduled cooling and heating capacity, selected and rated in accordance with ARI 410.
- G. Units shall not be selected at high fan speed unless noted otherwise.
- H. Indoor units shall be provided with all necessary tags and decals to aid in the service and/or indicate caution areas. Electrical wiring diagrams shall be attached to the control panel access door. Lifting lugs shall be supplied to facilitate rigging of the air-handling unit.
- I. Outdoor and indoor units shall be of same manufacturer. Units shall be factory run tested to check cooling and heating operation, defrost initiation and termination, fan and blower rotation and control sequence. Units shall be designed to operate at ambient temperatures between 120 degrees F and 30 degrees F on cooling mode and 70 degrees F and 0 degrees F on heating mode. Cooling and heating capabilities shall be rated in accordance with ARI standards

1.12 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi
 - 2. Daikin
 - 3. LG

- B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
 - 1. Indoor and outdoor units, including accessories.
 - 2. Controls and software.
 - 3. HRCUs.
 - 4. Refrigerant isolation valves.
 - 5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
 - 1. Two-pipe or three-pipe system design.
 - 2. System(s) operation, air-conditioning, heat pump or heat recovery as indicated on Drawings.
 - 3. Each system with one refrigerant circuit shared by all indoor units connected to system.
- 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. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
- D. ASHRAE Compliance:
 - 1. ASHRAE 15: For safety code for mechanical refrigeration.
 - 2. ASHRAE 62.1: For indoor air quality.
 - 3. ASHRAE 135: For control network protocol with remote communication.
 - 4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
- E. UL Compliance: Comply with UL 1995.

2.3 INDOOR UNITS

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
 - 1. Concealed unit cabinet material: Galvanized painted steel.

2. Exposed cabinet material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
 3. Exposed wall mounted unit cabinet material
 4. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
 5. For ducted units: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
 6. Mounting: Manufacturer-designed provisions for field installation.
 7. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
1. Coil Casing: Aluminum, galvanized, or stainless steel.
 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 5. Unit Internal Tubing: Copper tubing with brazed joints.
 6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 7. Field Piping Connections: Manufacturer's standard.
 8. Factory Charge: Dehydrated air or nitrogen.
 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 2. Condensate Removal:
 - a. Ceiling or Wall Mounted units: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
 - b. Floor Mounted Units: Provide unit with field installed condensate pump accessory if unit cannot be gravity drain to floor drain at the units.
 3. Field Piping Connection: Non-ferrous material.
- E. Fan and Motor Assembly:
1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.

- c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
 - d. Wheels statically and dynamically balanced.
 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
 5. Vibration Control: Integral isolation to dampen vibration transmission.
 - F. Filter Assembly:
 1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
 2. Efficiency: ASHRAE 52.2, MERV 7.
 3. Media: Manufacturer's standard replaceable or washable filter.
 - G. Grille Assembly:
 1. Floor or Wall Mounted Unit: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top of unit cabinet
 2. Ceiling Mounted Unit: Mounted in bottom of unit cabinet.
 - a. Supply Grille Assembly:
 - 1) Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
 - 2) Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
 - 3) Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
 - 4) Retain "Motorized Vanes" or "Additional Branch Supply Duct Connection" Subparagraph below, or both, to provide grille assembly with additional features. Features indicated may not be available from all manufacturers on all products. Consult manufacturers for availability.
 - 5) Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
 - 6) Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.
 - b. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet
 - H. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
3. Condensate Pump: Integral reservoir and control with electrical power connection at unit.

I. Unit Controls:

1. This unit shall use controls provided by the VFR System manufacturer to perform functions necessary to operate the system.
2. The units shall have a factory built in receiver for wireless remote control.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F - 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

J. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.
2. Field Connection: Single point connection to power unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways.

2.4 OUTDOOR UNITS, AIR-SOURCE HEAT-PUMP AND HEAT RECOVERY UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, or for use in systems with simultaneous heating and cooling, as indicated on the drawings.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

- B. Cabinet:
 - 1. Galvanized steel and coated with a corrosion-resistant finish.
 - a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.
 - 2. Mounting: Manufacturer-designed provisions for field installation.
 - 3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

- C. Compressor and Motor Assembly:
 - 1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
 - 2. Protection: Integral protection against the following:
 - a. High refrigerant pressure.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations.
 - f. Phase failure and phase reversal.
 - g. Short cycling.
 - 3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
 - 4. Vibration Control: Integral isolation to dampen vibration transmission.
 - 5. Oil management system to ensure safe and proper lubrication over entire operating range.
 - 6. Crankcase heaters with integral control to maintain safe operating temperature.
 - 7. Fusible plug.

- D. Condenser Coil Assembly:
 - 1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.
 - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
 - 2. Aluminum Microchannel Coils:
 - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - b. Single- or multiple-pass arrangement.
 - c. Construct fins, tubes, and header manifolds of aluminum alloy.
 - 3. Coating: Seacoast Protection Coating.
 - 4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

- E. Condenser Fan and Motor Assembly:
 - 1. Fan(s): Propeller type.
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. Statically and dynamically balanced.
 - 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 - 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 - 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 - 5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
 - 6. Vibration Control: Integral isolation to dampen vibration transmission.

- F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

- G. Unit Controls:
 - 1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 - 2. Factory-Installed Controller: Configurable digital control.
 - 3. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.
 - b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - f. Oil level.
 - 4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, night setback control, power consumption display, run test switch and equalize run time between multiple same components.
 - 5. Communication: Network communication with indoor units and other outdoor unit(s).
 - 6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

- H. Unit Electrical:
 - 1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
 - 2. Field Connection: Single point connection to power entire unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.
- I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for 1000 hours according to ASTM B117.
- J. Unit Piping:
 - 1. Unit Tubing: Copper tubing with brazed joints.
 - 2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 - 3. Field Piping Connections: Manufacturer's standard.
 - 4. Factory Charge: Dehydrated air or nitrogen.
 - 5. Testing: Factory pressure tested and verified to be without leaks.

2.5 HEAT RECOVERY CONTROL UNITS (HRCUs)

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
 - 1. Specially designed for use in systems with simultaneous heating and cooling.
 - 2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
- B. Cabinet:
 - 1. Galvanized-steel construction.
 - 2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
 - 3. Mounting: Manufacturer-designed provisions for field installation.
 - 4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

- C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

- D. Refrigeration Assemblies and Specialties:
 - 1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
 - 2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.
 - 3. Spares: Each heat recovery control unit shall include at least one branch circuit port(s) for future use.
 - 4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
 - 5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
 - a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

- E. Unit Controls:
 - 1. This unit shall use controls provided by the VFR System manufacturer to perform functions necessary to operate the system.

- F. Unit Electrical:
 - 1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
 - 2. Field Connection: Single point connection to power entire unit and integral controls.
 - 3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
 - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
 - 5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

- G. Unit Piping:
 - 1. Unit Tubing: Copper tubing with brazed joints.
 - 2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 - 3. Field Piping Connections: Manufacturer's standard.
 - 4. Factory Charge: Dehydrated air or nitrogen.
 - 5. Testing: Factory pressure tested and verified to be without leaks.

2.6 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a TIA-485A or manufacturer-selected control network.
2. Network Communication Protocol: Open control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
 - a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
 - b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
 - c. Integration shall include control, monitoring and scheduling.
4. Operator Interface:
 - a. Operators shall interface with system and unit controls through the following:
 - 1) Operator interfaces integral to controllers.
 - 2) Owner-furnished PC connected to central controller(s).
 - 3) Web interface through web browser software.
 - 4) Integration with Building Automation System.
 - b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:
 - 1) On/off control.
 - 2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.

5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages.
10. Supports Imperial and Metric Temperature Units: Fahrenheit and Celsius.
11. Monitors and displays cumulative operating time of indoor units.
12. Able to disable and enable operation of individual controllers for indoor units.
13. Information displayed on individual controllers shall also be available for display.
14. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
 - a. Include multiple interconnected controllers as required.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
 - a. Sets schedule for daily, weekly, and annual events.
 - b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
 12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.
- D. Wired Controllers for Indoor Units:
1. Single controller capable of controlling multiple indoor units as group.
 2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
 3. Multiple Language.
 4. Temperature Units: Fahrenheit and Celsius.
 5. On/Off: Turns indoor unit on or off.
 6. Hold: Hold operation settings until hold is released.
 7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
 8. Temperature Display: 1-degree increments.
 9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.
 10. Relative Humidity Display: 1 percent increments.
 11. Relative Humidity Set-Point: Adjustable in 1 percent increments.
 12. Fan Speed Setting: Select between available options furnished with the unit.
 13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
 14. Seven-day programmable operating schedule with minimum five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
 15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
 16. Occupancy detection.
 17. Service Notification Display.
 18. Service Run Tests: Limit use by service personnel to troubleshoot operation.
 19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
 20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
 21. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
 22. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.
- E. Wireless Controllers for Indoor Units:
1. Wireless controllers may be utilized and shall perform the same functions as the wire controller with additional requirements listed herein.
 2. Wireless Communication:

- a. Controller communicates to remote-mounted receiver that is wired to indoor unit(s).
 - 1) Include receivers with wireless controllers as required to complete installation.
 - 2) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.
 - b. One wireless controller shall be capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.
3. Controller Battery Life: Minimum Three years.

2.7 SYSTEM REFRIGERANT AND OIL

- A. Refrigerant:
1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
 2. ASHRAE 34, Class A1 refrigerant classification.
 3. R-410a.

2.8 SYSTEM REFRIGERANT PIPING

- A. Comply with requirements in Division 23 Section "Refrigerant Piping" for system piping requirements and VRF manufacturer's installation instructions. Provide all required components and specialty fittings by VRF system manufacturer.

2.9 SYSTEM HYDRONIC PIPING

- A. Comply with requirements in Section 23 21 13 "Hydronic Piping" for system piping requirements

2.10 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect factory-assembled equipment.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 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 products before installation. Reject products that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
- D. For units with ductwork, examine roughing-in for ductwork to verify actual locations of connections before equipment installation.
- E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
- F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Clearance:
 - 1. Maintain manufacturer's recommended clearances for service and maintenance.
 - 2. Maintain clearances required by governing code.
- B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
 - 1. Loose components shall be installed by manufacturer's service representative.
- C. Comply with mounting and anchoring requirements for seismic installations

3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.

- B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (10 mm).
 - C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
 - D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
 - E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
 - F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
 - G. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
 - H. Install floor-mounted units on support structure indicated on Drawings.
 - I. Install floor-mounted units on cast-in-place concrete equipment bases or on support structure. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
 - J. Attachment: Install hardware for proper attachment to supported equipment.
 - K. Grouting: Place grout under equipment supports and make bearing surface smooth.
- 3.4 INSTALLATION OF OUTDOOR UNITS
- A. Install units to be level and plumb while providing a neat and finished appearance.
 - B. Install outdoor units on support structures indicated on Drawings.
 - C. Install ground-mounting, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base. Tie or bolt unit to concrete base to accommodate code for wind requirements
 - D. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Division 23 Section Hangers and Supports for HVAC Equipment.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Refer to Division 23 Section "Refrigerant Piping" for installation requirements for refrigerant piping.
- B. Refer to Division 23 Section "Hydronic Piping" for installation requirements for hydronic piping.
- C. Install refrigerant piping per VRF system manufacturer's installation requirements.
- D. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

3.6 ELECTRICAL INSTALLATION

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.
 - 1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.
- C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

3.7 INSTALLATION OF SYSTEM CONTROL CABLE

- A. Comply with manufacturer's installation requirements.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
 - 1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
 - 2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

- a. First Visit: Kick-off meeting.
 - b. Second Visit: At approximately 25 percent completion of system(s).
 - c. Third Visit: At approximately 50 percent completion of system(s).
 - d. Fourth Visit: At approximately 75 percent completion of system(s).
 - e. Fifth Visit: Final inspection before system startup.
3. Kick-off Meeting:
- a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
 - b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
 - c. Meeting shall cover the following as a minimum requirement:
 - 1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
 - 2) Manufacturer's installation requirements specific to systems being installed.
 - 3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
 - 4) Required field activities related installation of VRF HVAC system.
 - 5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
4. Site Visits: Activities for each site visit shall include the following:
- a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
 - b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
 - c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
 - d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
 - e. Issue a report for each visit, documenting the visit.
 - 1) Report to include name and contact information of individual making the visit.
 - 2) Date(s) and time frames while on-site.
 - 3) Names and contact information of people meeting with while on-site.
 - 4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:
 - a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
 - b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
 - c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
 - d. Inspection reports for indoor units shall include, but not be limited to, the following:
 - 1) Unit designation on Drawings.
 - 2) Manufacturer model number.
 - 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.
 - 7) Proper service clearance provided.
 - 8) Wiring and power connections correct.
 - 9) Line-voltage reading(s) within acceptable range.
 - 10) Wiring and controls connections correct.
 - 11) Low-voltage reading(s) within an acceptable range.
 - 12) Controller type and model controlling unit.
 - 13) Controller location.
 - 14) Temperature settings and readings within an acceptable range.
 - 15) Humidity settings and readings within an acceptable range.
 - 16) Condensate removal acceptable.
 - 17) Fan settings and readings within an acceptable range.
 - 18) Unit airflow direction within an acceptable range.
 - 19) If applicable, fan external static pressure setting.
 - 20) Filter type and condition acceptable.
 - 21) Noise level within an acceptable range.
 - 22) Refrigerant piping properly connected and insulated.
 - 23) Condensate drain piping properly connected and insulated.
 - 24) If applicable, ductwork properly connected.
 - 25) If applicable, external interlocks properly connected.
 - e. Inspection reports for outdoor units shall include, but not be limited to, the following:
 - 1) Unit designation on Drawings.
 - 2) Manufacturer model number.

- 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.
 - 7) Proper service clearance provided.
 - 8) Wiring and power connections correct.
 - 9) Line-voltage reading(s) within acceptable range.
 - 10) Wiring and controls connections correct.
 - 11) Low-voltage reading(s) within an acceptable range.
 - 12) Condensate removal acceptable.
 - 13) Noise level within an acceptable range.
 - 14) Refrigerant piping properly connected and insulated.
 - 15) Condensate drain piping properly connected and insulated.
- f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:
- 1) Unit designation on Drawings.
 - 2) Manufacturer model number.
 - 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.
 - 7) Proper service clearance provided.
 - 8) Wiring and power connections correct.
 - 9) Line-voltage reading(s) within acceptable range.
 - 10) Wiring and controls connections correct.
 - 11) Low-voltage reading(s) within an acceptable range.
 - 12) Controller type and model controlling unit.
 - 13) Controller location.
 - 14) Temperature settings and readings within an acceptable range.
 - 15) Humidity settings and readings within an acceptable range.
 - 16) Condensate removal acceptable.
 - 17) Fan settings and readings within an acceptable range.
 - 18) Fan external static pressure setting.
 - 19) Filter type and condition acceptable.
 - 20) Noise level within an acceptable range.
 - 21) Refrigerant piping properly connected and insulated.
 - 22) Condensate drain piping properly connected and insulated.
 - 23) Automatic dampers properly installed and operating.
 - 24) Ductwork properly connected.
 - 25) If applicable, external interlocks properly connected.
- g. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

- h. Installer shall correct observed deficiencies found by the inspection.
 - i. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
 - j. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
 - k. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.
- B. Perform the following tests and inspections with the assistance of manufacturer's service representative:
- 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Refrigerant Tubing Positive Pressure Testing:
- 1. Comply with VRF HVAC system manufacturer's requirements.
 - 2. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
 - 3. Submit test reports for Project record.
- D. Refrigerant Tubing Evacuation Testing:
- 1. Comply with VRF HVAC system manufacturer's requirements.

2. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
 3. Submit test reports for Project record.
 4. Upon successful completion of evacuation testing, system shall be charged with refrigerant.
- E. System Refrigerant Charge:
1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
 2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
 3. System refrigerant charging shall be witnessed by system manufacturer's representative.
 4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.
- F. Products will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.
- 3.9 STARTUP SERVICE
- A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
 2. Complete startup service of each separate system.
 3. Complete system startup service according to manufacturer's written instructions.

- B. Startup checks shall include, but not be limited to, the following:
 - 1. Check control communications of equipment and each operating component in system(s).
 - 2. Check each indoor unit's response to demand for cooling and heating.
 - 3. Check each indoor unit's response to changes in airflow settings.
 - 4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
 - 5. Check sound levels of each indoor and outdoor unit.

- C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
 - 1. Installer shall correct deficiencies found during startup service for reverification.

- D. System Operation Report:
 - 1. After completion of startup service, manufacturer shall issue a report for each separate system.
 - 2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
 - 3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.
 - a. All available system operating parameters shall be included in the information submitted.

3.10 ADJUSTING

- A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

- B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

- C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

- D. Occupancy Adjustments: 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.

3.11 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include two service visits for preventive maintenance, repair or

replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two 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 and access the system and to upgrade computer equipment if necessary.

3.13 DEMONSTRATION

- A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- B. Instructor:
 - 1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
- C. Schedule and Duration:
 - 1. Schedule training with Owner at least 20 business days before first training session.
 - 2. Training shall occur before Owner occupancy.
 - 3. Training shall be held at mutually agreed date and time during normal business hours.
- D. Location: Owner shall provide a suitable on-site location to host classroom training.
- E. Training Attendees: Assume three people.
- F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.
- G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

- H. Training Materials: Provide training materials in electronic format to each attendee.
 - 1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

- I. Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

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SECTION 26 00 00 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

- A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.
- B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:
 - 1. "Provide" or "provided" shall mean "furnish and install".
 - 2. "Furnish" or "furnished" does not include installation.
 - 3. "Install" or "installed" does not include furnishing.
- C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.
- D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.
- E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.
- F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.
- G. Where architectural features govern location of work, refer to Architectural Drawings.
- H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.3 RELATED WORK

- A. Utility Services:
 - 1. Determine utility connection requirements and include in Base Bid all costs to Owner for utility service.
 - 2. Include costs for temporary service, temporary routing of service or other requirements of a temporary nature associated with utility service.
- B. Temporary Services:
 - 1. Division 01 - Temporary Utilities.
- C. Continuity of Service:
 - 1. No service shall be interrupted or changed without permission from Owner's Representative. Obtain written permission before work is started.
 - 2. When interruption of services is required, Owner's Representative, and other concerned parties shall be notified and shall determine a time.
- D. Concrete Work:
 - 1. Concrete shall comply with Division 03 - Concrete.
- E. Painting:
 - 1. Furnish equipment with factory-applied finish coats or paint equipment per Division 09 – Finishes unless specified otherwise.
 - 2. Furnish equipment with factory applied prime finish unless otherwise specified.
 - 3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Owner's Representative.
 - 4. Furnish one can of touch up paint for each final factory-applied finish coat of product.
- F. Sustainable Architecture and LEED Requirements:
 - 1. Provide services, documentation, and product data required to meet LEED credits involving an electrical component.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

- A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.5 REFERENCE STANDARDS

- A. Agencies or publications referenced herein refer to the following:
 - 1. AEIC Association of Edison Illuminating Companies
 - 2. ANSI American National Standards Institute
 - 3. ASME American Society of Mechanical Engineers

4. ASTM American Society for Testing and Materials
5. BICSI Building Industry Consulting Services International
6. EIA Electronic Industries Association
7. FIPS Federal Information Processing Standards
8. FCC Federal Communications Commission
9. ICEA Insulated Cable Engineers Association
10. IEEE Institute of Electrical & Electronics Engineers
11. IESNA Illuminating Engineering Society of North America
12. NEC National Electrical Code
13. NECA National Electrical Contractors Association
14. NEMA National Electrical Manufacturers Association
15. NESC National Electrical Safety Code
16. NETA National Electrical Testing Association
17. NFPA National Fire Protection Association
18. NIST National Institute of Standards & Technology
19. OSHA Occupational Safety and Health Administration
20. TIA Telecommunications Industries Association
21. UL Underwriters Laboratories, Inc.

- B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 LISTING

- A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.
- B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.7 ENCLOSURES

- A. Typical NEMA Enclosures and Usage
1. NEMA 1 - Indoors. Falling dirt.
 2. NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing.
 3. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust.
 4. NEMA 3X - Same as NEMA 3 plus corrosion resistant.
 5. NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered.
 6. NEMA 3SX - Same as NEMA 3S plus corrosion resistant.
 7. NEMA 3R - Outdoors. Rain, snow, sleet.
 8. NEMA 3RX - Same as NEMA 3R plus corrosion resistant.
 9. NEMA 4 - Indoors. Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down.
 10. NEMA 4X - Same as NEMA 4 - Indoors plus corrosion resistant.

11. NEMA 4 - Outdoors. Rain, sleet, snow. Wind-blown dust. Hose down.
12. NEMA 4X - Same as NEMA 4 - Outdoors plus corrosion resistant.
13. NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers.
14. NEMA 6 - Indoors. Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.
15. NEMA 6P - Same as NEMA 6 - Indoors plus corrosion resistant. Prolonged submersion.
16. NEMA 6 - Outdoors. Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.
17. NEMA 6P - Same as NEMA 6 - Outdoors plus corrosion resistant. Prolonged Submersion.
18. NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
19. NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
20. NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.
21. NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.

1.8 SUBMITTALS

- A. Shop Drawings (Product Data):
 1. Refer to Division 01 - Submittal Procedures.
 2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
 3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
 4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
 5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
 6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
 7. Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
 8. Include wiring diagrams for electrically powered or controlled equipment.
 9. Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and required working clearances. Submit electrical equipment room layouts concurrently with electrical distribution equipment submittals.

10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
 11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
 12. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
- B. Certificates and Inspections:
1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
- C. Operation and Maintenance Manuals:
1. Refer to Division 01 - Operation and Maintenance Data.
 2. Upon completion of work but before final acceptance of system, submit to Owner's Representative for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner's Representative.
 3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
 4. Manuals shall include the following:
 - a. Copies of shop drawings
 - b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.
 - c. CD ROM's of O&M data with exploded parts lists where available.
 - d. Phone numbers and addresses of local parts suppliers and service companies
 - e. Internet/WEB page addresses where applicable
 - f. Wiring diagrams
 - g. Start up and shut down procedure
 - h. Factory and field test records
 - i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
 5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
 6. Furnish O&M manuals and instructions to Owner Representative prior to request for final payment.

- D. Record Documents:
1. Refer to General Conditions of Contract and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
 2. Use designated set of prints of Contract Documents as prepared by Owner's Representative to mark-up for record drawing purposes.
 3. Provide approved power system in a 3-ring binder 2" max. thickness. Include the SKM power system study modeling file on a thumb drive attached to the binder.

1.9 JOB CONDITIONS

- A. Building Access:
1. Arrange for necessary openings in building to allow for admittance of all apparatus.
 2. Electric rooms in the custody of the University (supplying power to campus programs or entities)
 - a. Only authorized and trained individuals may have access to electrical rooms.
 - b. Electric rooms are to be supervised by an authorized person when the doors open and work is commencing.
 - c. Electric rooms will not be left unattended while the door is open.
 - d. Dust control for work will be used at all times to protect new or existing equipment.
 - e. All provisions regarding electrical safety per NFPA 70E will be followed.
 3. Electrical rooms in the custody of the Contractor (not supplying power to campus programs or entities)
 - a. Contractor is responsible for coordinating access with trades and work groups.
 - b. All provisions regarding electrical safety per NFPA 70E will be followed.
 - c. Dust control for work will be used at all times to protect existing or new equipment.
- B. Coordination:
1. Equipment provided under other Divisions of these specifications.
 - a. Motors
 - b. Electrically powered equipment
 - c. Electrically controlled equipment
 - d. Starters, where specified
 - e. Variable frequency drives, where specified
 - f. Control devices, where specified
 - g. Temperature Control wiring

2. Provide the following devices required for control of motors or electrical equipment, unless noted otherwise:
 - a. Starters
 - b. Disconnect devices
 - c. Control devices
 - 1) Pushbuttons
 - 2) Pilot lights
 - 3) Contacts
 - d. Conduit, boxes and wiring for Power wiring
 - e. Conduit, boxes and wiring for Control wiring, except for control wiring systems as defined in Section 23 09 01.
 3. Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.
 4. Wire starters or other similar control devices furnished by others.
 5. This contractor's drawings and/or specifications show number and hp rating of motors furnished by others, together with their actuating devices. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, Contractor responsible for change shall immediately notify this Contractor. Additional costs due to these changes shall be responsibility of Contractor initiating change.
 6. Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, rain tight, explosion proof, dust tight, or any other special type as required.)
 7. Comply with local utility motor starting requirements and provide starters for motors furnished by others as specified herein or under various trade sections of those specifications.
- C. Cutting and Patching:
1. Refer to General Conditions of the Contract and Division 01 - Cutting and Patching.
 2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
 3. Provide materials required for patching unless otherwise noted.
 4. Do not pierce beams or columns without permission of Owner's Representative and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
 5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

- D. Housekeeping and Cleanup:
 - 1. Refer to Division 01 - Closeout Procedures.
 - 2. As work progresses or as directed by Owner's Representative, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.10 WARRANTY

- A. Refer to Division 01 for general warranty requirements.
- B. Refer to technical sections for warranty requirement for each system.
- C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.
- D. In any case, wherein fulfilling requirements of any guarantee, if this contractor disturbs any work guaranteed under another contract, this contractor shall restore such disturbed work to condition satisfactory to Owner's Representative and guarantee such restored work to same extent as it was guaranteed under such other contract.
- E. Warranty shall include labor, material, and travel time.

1.11 UNIVERSITY REQUIREMENTS

- A. Power system study, Electrical Coordination, Fault Duty Assessment, Fire Ignition and Arc Flash:
 - 1. Comply with NFPA 70E – Standard for Electrical Safety in the Workplace and IEEE 1584-2002– Guide for Performing Arc Flash Calculations. Perform an Arc Flash Hazard Analysis to determine the Flash Hazard Boundary, Incident Energy, Hazard Risk Category, Shock Hazard Voltage, Required Glove Class, Limited Approach Boundary, Restricted Approach Boundary and Prohibited Approach Boundary.
 - 2. Submit arc flash label with above data to university representative for approval. Label will be consistent with existing labels on campus.
 - 3. At a minimum, the following electrical equipment will be studied: All Switchgear, Distribution Boards, Panel Boards, Equipment Disconnects, VFD Enclosures, Motor Controllers, Motor Control Centers, Medium Voltage Switchgear Enclosures, Medium Voltage Transformer Enclosures, control panels, lighting control panels and relay enclosures and any electrical enclosure with a hinged door.
 - 4. Arc flash calculations will be completed using the SKM software to match the rest of the campus study. Submit the arc flash report prepared by the registered professional engineers of record that performed the study. Include the SKM files

- and the database used to perform the study, on a CT and submit with the completed study. Install required arc flash labels on campus equipment.
5. See 26 05 73 "Power System Study" for additional information and requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide all electrical distribution equipment from a single source manufacturer.

2.2 PRODUCT SUBSTITUTIONS

- A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.
- C. Store in clean, dry space.
- D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with manufacturer's written instructions.
- F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.
- G. Provide supplemental heat if required to prevent moisture contamination.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

- A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

- B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.
- C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.
- D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.
- E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.
- F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 26 05 93 - Electrical Systems Firestopping.
- G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Submit drawings for approval prior to preparing openings in structural member.
- H. Provide 2" clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.
- I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.
- J. Seal non-rated wall openings with urethane caulk.
- K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Owner's Representative. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.
- L. Finish and trim penetrations as shown on details and as specified.
- M. Provide chrome or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for

finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

- N. In Bio-safety and Wash down areas,
1. Exposed conduit penetrations shall be sealed as follows:
 - a. Escutcheons shall not be used when conduits are exposed in finished areas and penetrate finished surfaces.
 - b. Cut and patch penetration to within 1/4" of conduit.
 - c. Seal openings around conduit and patch work with sealants specified in Division 07 –
 - d. Joint Sealants. Sealant shall be installed per manufacturer's application requirements.
 2. Penetrations other than conduits (junction boxes, light fixtures, etc.) including wiring devices shall be sealed as follows:
 - a. Seal non-rated opening with silicone sealant.
 - b. See drawings for details.
 - c. Confirm selected sealant is compatible with paint provided by others prior to application.
 - d. Product: One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substances indicated, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes; subject to compliance with requirements. Provide one of the following:
 - 1) 786 Mildew Resistant Silicone Sealant; Dow Corning Corp. or equal
 - 2) Sanitary 1700 Silicone Sealant; General Electric Co. or equal
 - 3) 898 Silicone Sanitary Sealant; Pecora Corp. or equal
 - 4) Tremsil 600; Tremco Corp. or equal
 - 5) OmniPlus; Sonneborn Building Products Div., Rexnord Chemical Products, Inc. or equal

3.4 EQUIPMENT ACCESS

- A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.
- B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.

- C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for equipment shall provide access for servicing, repairs and/or maintenance.
- D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions.
- E. Provide access doors in walls, chases or inaccessible ceilings for equipment requiring access for servicing, repairs and maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire-rated construction with UL label. Provide steel, prime-coated access doors in dry locations. Provide stainless steel access doors for use in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.
- F. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Owner's Representative reserves right to make minor position changes of outlet locations before work has been installed.
- G. Verify door swings before installing room light switch boxes. Install boxes on latch side of door unless otherwise noted
- H. Provide access to electrical equipment, raceway pullboxes and junction boxes no higher than 4' above a revocable ceiling tile or access hatch.

3.5 EQUIPMENT SUPPORTS

- A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.
- B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.
- C. Do not support equipment or luminaires from metal roof decking.

3.6 SUPPORT PROTECTION

- A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

- B. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.7 ELECTRICAL SYSTEMS IDENTIFICATION

- A. Refer to Section 26 05 53 – Electrical Systems Identification.

3.8 ACCEPTANCE TESTING

- A. Contractor shall engage testing and inspection agency to perform acceptance tests. Equipment to be tested is noted as "Testing by Testing Agency" in technical specification sections. Perform in accordance with Section 26 08 12 – Power Distribution Acceptance Tests and Section 26 08 13 – Power Distribution Acceptance Test Tables.
- B. When testing is to be witnessed by Owner's Representative, notify them at least 10 days prior to testing date.
- C. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials.
- D. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.
- E. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.9 START-UP

- A. Before energization for startup, testing, or use for energization of downstream systems, all electrical equipment must be inspected by the University IOR and/or the appropriate University Representative. All third-party testing should be complete and reports available for review at this time.
- B. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFICI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.
- C. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

- D. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.
- E. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.
- F. Coordinate start-up with all trades.

3.10 CLEANING

- A. Clean systems after installation is complete.
- B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.
- C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.
- D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.
- E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.
- F. During construction, maintain indoor air quality per general contractors IAQ plan for LEED credit.

3.11 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste management shall be managed in accordance with provisions of Section 01524 Construction Waste Management. Documentation shall be submitted to satisfy the requirements of that section.

END OF SECTION 26 00 00

SECTION 26 01 26 - ACCEPTANCE TESTING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 00 00 - General Electrical Requirements

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Test the following systems per NETA:
 1. Power distribution monitoring, control and relay equipment
 2. Overcurrent protection device settings
 3. Starters feeding motors 40 hp or greater
 4. Motors 40 hp or greater
 5. Feeders from service point through feeders serving panelboards of 400 A or greater
 6. Emergency or standby diesel driven generators
 7. Grounding system from service point through branch panelboard feeders
 8. Circuit breakers, transformers, medium voltage cable, low voltage (600V) wire.
 9. Computer room grounding system

1.4 INITIAL ACCEPTANCE TEST AND INSPECTION

- A. Perform acceptance test per National Electrical Testing Association Standard ATS -2017 except as modified herein.
- B. Perform on-site testing after equipment installation, unless otherwise noted.
- C. Provide material, equipment, labor, and technical supervision to perform such tests and inspections.
- D. Provide test power required.
- E. Coordinate testing schedule and equipment availability with Owner's Representative.
- F. Notify Owner's Representative 1 week before testing.

- G. Prepare test results with comparison to industry and manufacturer's values and tolerances.
- H. Assure electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with Contract Documents.
- I. Provide recommendations for suitability of continued energization.

1.5 WORK NOT INCLUDED

- A. Prime mover testing (turbines or engines) will be performed by others.
- B. Uninterruptible Power Systems

1.6 APPLICABLE CODES, STANDARDS AND REFERENCES

- A. Perform inspections and tests in accordance with the following Codes and Standards:
 - 1. National Electrical Code - NEC
 - 2. National Electrical Manufacturer's Association - NEMA
 - 3. American Society for Testing and Materials - ASTM
 - 4. American National Standards Institute - ANSI
 - 5. Institute of Electrical and Electronic Engineers - IEEE
 - 6. National Electrical Testing Association - NETA
 - 7. State and Local Codes and Ordinances
 - 8. Insulated Cable Engineers Association - ICEA
 - 9. Association of Edison Illuminating Companies - AEIC
 - 10. OSHA - Part 1910: Subpart S - 1910.308
- B. Perform inspections and tests in accordance with the following references.
 - 1. Project Design Specifications
 - 2. Project Design Drawings
 - 3. Manufacturer's instruction manuals
 - 4. Manufacturer's shop drawings
- C. Qualifications of Testing Agency
 - 1. Member of NETA.
 - 2. Meet Federal Department of Commerce requirements for independent testing laboratory accreditation.
 - 3. Submit proof of above qualifications to Owner's Representative.

1.7 SUBMITTALS

- A. Provide 5 copies of complete testing report using NETA printed forms. Test report includes the following: summary of project, description of equipment tested,

description of test, test results, conclusion and recommendation, and signature of responsible test organization authority.

- B. Submit completed report to Owner's Representative no later than 30 days after completion of testing, unless directed otherwise.
- C. Acceptance test reports are required for IOR inspection before initial energization.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 THE FOLLOWING INDICATES APPLICABLE NETA STANDARD ATS - 2017 SECTIONS FOR THIS PROJECT.

- A. ELECTRICAL ACCEPTANCE TESTS
 - 1. GENERAL
 - a. Test Instrument Calibration
 - b. Test Report: acceptance test reports are required for IOR inspection before initial energization of any component
 - c. Safety & Precautions
 - 2. INSPECTION AND TEST PROCEDURES:
 - a. Metal Enclosed Switchgear and Switchboard Assemblies
 - b. Transformers
 - 1) Transformers - Dry Type, Oil Filled Medium Voltage
 - c. Cables
 - 1) Cables - Low Voltage - 600 Maximum
 - 2) Cables - Medium and High Voltage - 69 kV Maximum
 - d. Switches
 - 1) Transformer wire and cable
 - e. Circuit Breakers
 - 1) Circuit Breakers - Low Voltage
 - a) Circuit Breakers - 400A and Greater (primary current injection)
 - b) Circuit Breakers - 100A and greater with Microprocessor trip unit.
 - f. Protective Relays
 - 1) Visual and Mechanical Inspection
 - 2) Electrical Tests
 - g. Instrument Transformers
 - 1) Visual and Mechanical Inspection
 - 2) Electrical Tests - Current Transformers

- 3) Electrical Tests - Voltage Transformers
- 4) Electrical Tests – Potential Transformers
- 5) Test Values
- h. Metering and Instrumentation
 - 1) Visual and Mechanical Inspection
 - 2) Electrical Tests
- i. Grounding Systems
 - 1) Visual and Mechanical Inspection
 - 2) Electrical Tests
 - 3) Test Values
- j. Ground Fault System
 - 1) Visual and Mechanical Inspection
 - 2) Electrical Tests
 - 3) Test Parameters
- k. Surge Arrestors
 - 1) Low Voltage Surge Protection Devices
 - 2) Medium and High Voltage Surge Protection Devices
- l. Capacitors
 - 1) Visual and Mechanical Inspection
 - 2) Electrical Tests
 - 3) Test Values
- 3. SYSTEM FUNCTION TESTS:
- 4. THERMOGRAPHIC SURVEY
- 5. TABLES

END OF SECTION 26 01 26

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of this Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section Includes:
 1. Materials and equipment shall be furnished and installed in support of electrical work described in these plans and specifications including but not limited to, raceways, boxes, enclosures, feeders, branch circuiting, supports, terminal cabinets, sleeves, gutters, panels, transformers, lighting fixtures, controls, relays, contactors, in order to complete and make fully functional the systems described. All materials shall be new and/or never previously installed.
 2. Complete fire alarm and annunciation system as shown and/or required by the (local jurisdiction having authority, California State Fire Marshal) including monitoring equipment and wiring for central station connection.
 3. Lighting systems as shown on the plans and as specified herein, including controls, occupancy sensors, lumen sensors, photocell controls, lamps, dimmers, supports, fasteners, straps, and miscellaneous mounting hardware and support structures for such equipment.
 4. Duct banks and raceways for all power and communications systems as shown and/or required. Duct banks shall include all trenching, racking, conduit, concrete, backfill, boxes, pads, substructures required for a fully developed and useable pathway for cables, conductors, as shown on site, etc.
 5. HVAC and plumbing electrical: Conduit, conductors and terminations for all line voltage power, line voltage controls and fusible safety disconnect switches for HVAC equipment, including but not limited to air conditioners, furnaces, fans, heat pumps, cooling towers, system pumps, condensing units. Provide protective equipment unless otherwise noted, etc. including protective devices.
 6. Plumbing Electrical: Conduit, conductors and terminations for plumbing equipment with power requirements including necessary fusible and/or non-fusible safety disconnect devices. Provide motor starters where required unless provided by mechanical specification.
 7. Power and Lighting Distribution: Furnish and install power and lighting distribution systems including but not limited to panels, feeders, transformers,

- branch circuits, devices, fixtures, disconnect switches, contactors, controls, etc. for a complete working system.
8. Data systems infrastructure including all boxes, raceways, cable tray, wire basket tray, dedicated branch circuits, sleeves and penetrations, etc. as described and as shown in plans, risers, specifications, EIA/TIA standards and/or required for a complete and operating system.
 9. Allocation of time to adequately train the Owner on the use and operation of all systems installed within the facility or on the property. Minimum two-week advance notice shall be coordinated with the Owner and his representatives. Training shall be as outlined in individual system specifications identified to follow.
 10. Cal Poly Campus Standards for Common Work Results for Electrical
- B. Related Sections Under Other Divisions:
1. Mechanical Wiring: Control circuit wiring, energy management controls and interlocks for mechanical equipment shall be installed by Mechanical Contractor.
 2. Painting of electrical equipment where exposed and required by the Architect to be painted as described elsewhere in the specification.
 3. Pole Bases: Contractor shall be responsible to furnish light standard concrete pole bases, rebar, bolt templates and anchor bolt kits for a complete installation. Concrete, rebar, excavation shall be by Contractor in accordance with all parts of this specification.
 4. HVAC Control Raceway: Raceways, boxes, and control wiring for thermostats, temperature sensors and control components specified within the mechanical specifications, shall be furnished and installed as required by Division 25 and installed in accordance with the minimum wiring methods allowed for branch circuit wiring in Division 26 (the DDC systems/EMS systems and components are installed in accordance with Division 25).
 5. Smoke Fire Dampers: Coordination with Mechanical plans for exact locations and points of connection for power and fire alarm system connections (power and fire alarm connection shall be by Electrical Contractor).
 6. Duct mounted smoke detectors: Coordination with Mechanical plans for exact locations and points of connection for power and fire alarm system connections (power and fire alarm connection shall be by Electrical Contractor).
 7. Security System: Shall be installed by Owner's vendor. Contractor shall provide conduits, boxes, stubs to accessible ceilings, dedicated circuit(s) for alarm panel, access control system (key pads, electric locks), etc. as shown and/or required by the Owner's vendor.

1.3 SYSTEM DESCRIPTION

- A. The electrical plans indicate the general layout and arrangement; the architectural drawings and field conditions shall determine exact locations. Field verify all conditions and modify as required to satisfy design requirements as well as code minimums. Maintain all required working clearances as described in CEC Article 110 as well as other applicable articles.
- B. Discrepancies shall be brought immediately to the attention of the Architect for clarification. The Architect shall approve any changes. Prior to rough-in, refer to architectural plans that shall take precedence over electrical plans with respect to locations.

1.4 UNIVERSITY REQUIREMENTS

- A. Any electrical equipment operating over 250V phase to ground or above a 225A buss rating will be located in an electrical room with limited access. Electrical distribution equipment is not permitted to be installed in outdoor locations. Specific project requirements shall be reviewed with University representatives.
- B. All electrical rooms will not be designed with regard to floor plan so that access to other facilities of the building (machine rooms, telecom equipment, etc.) will have to pass through the electrical rooms.
- C. Electrical rooms will be compliant with NEC requirements regarding panic hardware and secondary exiting based on installed equipment ratings.
- D. All general building wiring conductors to be THHN/THWN
- E. All conductors regardless of size will be ordered and installed in their corresponding phase color. Phase tape is not acceptable.
- F. Color Coding: The following color code will be adhered to:
 - 1. 208/120V Systems:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral : White
 - 2. 240/139V Systems
 - a. Phase A: Black
 - b. Phase B: Purple
 - c. Phase C: Blue
 - 3. 480/277V Systems
 - a. Phase A : Brown

- b. Phase B: Orange
- c. Phase C: Yellow
- d. Neutral: Gray
- 4. 240/120V Systems
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Neutral: White
- 5. Medium Voltage Systems
 - a. Phase A: 1 Bands White Tape
 - b. Phase B: 2 Bands White Tape
 - c. Phase C: 3 Bands White Tape
- 6. All systems:
 - a. Switch Leg/travelers: Pink or Purple
 - b. Ground: Green
- 7. All systems:
 - a. 0-10V dimming pink and purple #14 AWG or smaller
- 8. Fire Alarm Systems:
 - a. SLC Circuit: Twisted Black and Red
 - b. Non-resettable 24V Power: Yellow and Blue
 - c. Resettable 24V Power: Pink and Purple
 - d. NAC Circuit: Brown and Orange, Brown and Yellow, Brown and Red, and Brown and Pink
- G. Armored cable is not permitted.
- H. Equipment Disconnects and Connections:
 - 1. Equipment disconnects are to be rated as the "Heavy Duty" type. Provide fused disconnects as un-fused disconnects are not acceptable.
 - 2. Use type LFMC to connect equipment to disconnecting means.
 - 3. Group II equipment owned by a University Department - Equipment operating at 480V must use a hard wired disconnect or an interlocked pin and sleeve or interlocked twist lock.
- I. Enclosures:
 - 1. Enclosures in exterior areas are to be NEMA 3R or 4X.
 - 2. Conduit entry into 3R enclosures will be via the bottom whenever possible. 3R enclosures entered from the side or the top will have "Myers Hubs" or factory hubs as appropriate.
 - 3. Conduit entry into 4X enclosures will employ the use of "Myers Hubs" or equivalent. Sealing lock washers are not permitted.

1.5 SUBMITTALS AND SHOP DRAWINGS

- A. Before construction, submit in (accordance with the General Conditions of this Specification) a complete list of all materials proposed to be furnished and installed under this section. Any material procured without review and approval of the engineer and/or owner's representative, will solely be at the contractor's risk.
- B. Manufacturers' specifications, catalog cuts and shop drawings as required to demonstrate compliance with the specifications. Identify specific intended use for each component where submittal may be ambiguous. Submit entire bound submittal at one time; partial submittals will not be accepted. At a minimum, submittals will be required for the following:
1. Utility service/site work equipment including ducts, conduits, fittings, concrete manholes, concrete and fiberglass pull, manhole, boxes, vaults, trench racks, accessories, etc.
 2. Distribution equipment including main switchboards, distribution switchgear, transformers, distribution panels and breakers, motor controls, distribution and branch circuit panels, grounding, transient voltage surge suppressors, etc.
 3. Electrical equipment including disconnects, fuses, raceways, straps and racks, fittings, conductors, boxes, gutters, devices, plates, etc.
 4. Lighting equipment including fixtures, ballasts, lamps, mounting accessories, color charts (where required), etc.
 5. Lighting control equipment including low voltage switching system, dimmer switchbank / accessories, occupancy sensing equipment, time clocks, contactors, photocells, lumen sensors, etc.
 6. Constructability review letter/comments for lighting acceptance testing as required by Section 26 56 70, LIGHTING ACCEPTANCE TESTING.
 7. Complete system component submittals and shop drawings for:
 - a. Fire Alarm System
 - b. Communication Systems including but not limited to; cable, fiber, terminations, cable management, cable tray, patch panels, equipment racks, specified active electronics (where called for), cabinets, jacks, plates, cable labeling, testing procedure.
 8. Conduit including all fittings, etc.
 9. Wiring and cable, terminations, etc.
 10. Fire rating penetration materials, details, etc.
- C. The intent of these specifications is to establish a standard of quality for materials and equipment. Therefore, some items are identified by manufacturer or trade name designation. Substitutions shall be subject to the Architect's approval. Samples of the proposed and substitute materials may be required for inspection prior to approval. Costs, if any, for evaluation of substitutions shall be the Contractor's responsibility. The

decision of the Architect shall be final. Where the substitution will affect other trades, coordinate all changes with those trades concerned and pay any additional costs incurred by them as a result of this substitution. Approval of substitutions shall not relieve the Contractor from providing an operational system in accordance with all applicable codes and ordinances.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Storage of equipment for the job is the responsibility of the Electrical Contractor and shall be scheduled for delivery to the site, as the equipment is required. Damage to the equipment delivered to the site or in transport to the job shall be the responsibility of the Electrical Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials shall be new and bear the label of or be listed by a nationally recognized testing laboratory. The quality and suitability of all materials shall conform to the standards and practices of this trade.
- B. Supplied materials shall be of a current manufactured product line. Discontinued products are not acceptable. Where products are identified on the contract documents by part number, supply the current product model or series which meets the specification and intended use of the specified component.

2.2 SUPPORTING DEVICES

- A. Hangers: Kindorf B-905-2A Channel, H-119-D washer, C105 strap, 3/8" rod with ceiling flange.
- B. Concrete Inserts: Kindorf D-255, cast in concrete for support fasteners for loads up to 800 lbs.
- C. Pipe Straps: Two-hole galvanized or malleable iron.
- D. Luminaire Chain: Campbell Chain 75031, 90-lb. test with steel hooks.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Professionalism and appearance of installations shall be in accordance with accepted practices of this trade. Installation methods shall conform to manufacturers' specifications and recommendations. The Contractor shall man the job with qualified journeymen and helpers in this trade for the duration of the job. It is the Contractor's responsibility to communicate with and keep the job superintendent apprised of changes or clarifications, etc.
- B. Employment of any person on any job in the capacity of an electrician is not permitted unless such person has qualified for and holds a valid Journeyman Electrician Pocket Card or General Journeyman Electrician Certificate issued by the State of California Division of Apprenticeship Standards except, Contractor may employ electrical helpers or apprentices on any job of electrical construction, new or existing, when the work of such helpers or apprentices is performed under the direct and constant personal supervision of a journeyman electrician holding a valid Pocket Card accepted by the State of California Division of Apprenticeship Standards.
 - 1. Each Pocket Card carrying journeyman electrician will be permitted to be responsible for the quality of workmanship for a maximum of one helper or apprentice during any same time period, provided the nature of work is such that good supervision can be maintained and the quality of workmanship is the best, as expected by Owner and implied by the latest edition of the National Electrical Code.
 - 2. Before each journeyman electrician commences work, deliver to Owner at the project site, a photocopy of the journeyman's valid Pocket Card.
- C. Materials shall be installed in accordance with the manufacturers' specification and recommendations. They must conform to the approval AHJ adopted codes and standards, but not less than the currently adopted CEC and all applicable codes and standards, including but not necessarily limited to California Code of Regulations Title 24, NFPA, National Electrical Manufacturers Association, ANSI, CBC, and any other adopted ordinances of applicable agencies having jurisdiction. Refer to general conditions of specifications.
- D. Electrical Contractor shall lay work out in advance in order to avoid unnecessary cutting, chasing, and drilling of floors, walls, ceilings and other surfaces. Work of this nature shall be carefully done so as not to damage work already performed by other trades. Any damage which results must be properly repaired at no extra cost to the Owner. Such alterations shall not depreciate the integrity of the structure. Approval for cuts or penetrations in structural members shall be by the Architect.

- E. Supporting Devices:
1. Verify mounting height of all luminaires or items prior to installation when heights are not detailed.
 2. Install vertical support members for equipment and luminaires, straight and parallel to building walls. Provide independent supports to structural member for electrical luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over furred or suspended ceilings.
 3. Do not use other trade's fastening devices as supporting means for electrical equipment, materials or luminaires. Do not use supports or fastening devices to support other than one particular item.
 4. Support conduits within 18" of outlets, boxes, panels, cabinets and deflections. Maximum distance between supports not to exceed 8' spacing.
 5. Securely suspend all junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from the floor above or roof structure to prevent sagging and swaying.
 6. Provide seismic bracing per UBC requirements for this building location.
 7. Supporting Devices: Safety factor of 4 required for every fastening device or support for electrical equipment installed. Support to withstand four times weight of equipment it supports. Bracing to comply with seismic design category "SDC" as per Structural Engineer.
- F. Coordinate work with other trades as required to eliminate any delays during construction. Coordinate changes with other prime contractors to avoid construction conflicts.
- G. Engineer's Field Observation: Site visits during construction for field observations and reports will be conducted by electrical engineer when directed by the Architect. A list of items that need to be addressed will be submitted to the Architect for forwarding to the Contractor. A written response to all items shall be submitted for Owner's review once complete. When Electrical Engineering representative performs a field observation, the Electrical Contractor shall be present and available to remove equipment covers as needed.
- H. Drawings of Record: Provide a full and accurate set of field record drawings marked up in a neat and understandable manner submitted to the Owner Representative, Construction Manager, or Architect upon completion of the work and prior to issuance of a certificate of completion. The drawings shall dimension all electrical facilities including but not limited to underground conduit, vaults, boxes as well as conduit routing scaled to within 12" of actual field conditions and shall be kept up to date on a daily basis reflecting changes or deviations. Electrical facilities shall be accurately drawn on the plan to scale. Refer to the general conditions of these specifications for additional requirements. Record drawings shall be required to identify both horizontal

and vertical dimensions to visible and fixed points such as concrete, asphalt, buildings, sidewalks, etc.

- I. Identification: Provide engraved laminated plastic nameplates for all switchboards, panelboards, fire alarm terminal cabinets, telephone and cable television backboards, main devices, control panels, time clocks, contactors and safety disconnect switches accurately identifying each device. Labels shall be self-adhesive; drilling of equipment to adhere labels is not permitted. Refer to Electrical System Identification for color requirements based on system.
- J. Safety: The Electrical Contractor is responsible to maintain equipment in a safe and responsible manner. Keep dead front equipment in place while equipment is energized. Conduct construction operations in a safe manner for employees as well as other work persons or anyone visiting the job site. Provide barriers, trench plates, flags, tape, etc. The Contractor shall hold all parties harmless of negligent safety practices that may cause injury to others on or near the job site. Contractor is responsible for following all parts of NFPA 70E including work practices and PPE requirements.
- K. Guarantees: Equipment and labor shall be guaranteed and warranted free of defects, unless otherwise stated to be more restrictive, for a period of one year from the date of final acceptance by the Owner. A written warranty shall be presented to the Architect at the time of completion prior to final acceptance. Equipment deemed to be damaged, broken or failed should be repaired or replaced at no additional cost to the Owner. Materials or system requiring longer than a one- year warranty as described herein shall be separately warranted in separate letters of guarantee stating the duration of warranty.
- L. Operating and Installation Manuals: Provide two copies each of manuals, operating and installation instructions for equipment indicated in submittal packages. Instruct the Owner's representative as to the operation and location of equipment necessary to allow them to operate the facility upon final acceptance. This instruction period shall be prearranged with the Owner's representative prior to occupancy of the facility and the weeks prior to training scheduled.
- M. Lighting Acceptance Testing: Provide two copies of lighting acceptance testing results and equipment operating manuals as specified in Section 26 56 70, LIGHTING ACCEPTANCE TESTING. Instruct the Owner on operation of control systems.

END OF SECTION 26 05 00

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SECTION 26 05 13.16 - MEDIUM-VOLTAGE SINGLE-CONDUCTOR CABLES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- B. Section 26 05 43 – Underground Ducts and Raceways for Electrical Systems
- C. Section 26 05 53 – Electrical Systems Identification
- D. Section 26 08 12 – Power Distribution Acceptance Tests
- E. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
- F. Section 26 13 16 – Medium Voltage Fusible Pad-Mounted Switchgear

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

- A. Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.
- B. Medium voltage cable. Single conductor 15 kV, 133% insulation ethylene propylene rubber (EPR) insulated, metallic tape shield, PVC jacketed, with copper conductors for use in underground distribution systems.
- C. Cables are for use in wet or dry locations, conduit, underground duct applications.
- D. Conductors shall be rated to operate at conductor temperature of 105°C for continuous normal operation, 140°C for emergency overload conditions, and 250°C for short circuit conditions, based on 40°C maximum ambient temperature.
- E. Conductor sizes in Section are based on copper wire and only copper wire shall be used.

1.4 REFERENCE STANDARDS

- A. ASTM: B3 Soft or Annealed Copper Wire.
- B. ASTM: B8 Concentric Lay-Stranded Copper Conductor, Hard, Medium-Hard or Soft.
- C. NEMA: WC8 Ethylene-Propylene, Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.
- D. NEMA: WC26 Wire and Cable Packaging.
- E. ANSI/Insulated Cable Engineers Association (ANSI/ICEA) Standard Publication No. S-97-682.
- F. Association of Edison Illuminating Companies (AEIC) Publication No. CS-8. Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 KV.
- G. NETA: Latest version of Acceptance Testing Standard.
- H. AEIC CS 8 – Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46kV.
- I. IEEE 48 – Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kV through 765kV.
- J. IEEE 386 – Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V (ANSI).
- K. IEEE 404 – Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 – 500000 V (ANSI)
- L. IEEE 576 – Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications (ANSI)
- M. ICEA S-93-639 – 5-46kV Shielded Power Cables for the Distribution and Transmission of Electrical Energy
- N. ICEA S-94-649 – 5-46kV Concentric Neutral Cables Rated 5000 to 46000 Volts
- O. ICEA S-97-682 – Utility Shielded Power Cables Rated 5000 to 46000 Volts
- P. NFPA 70 – National Electrical Code
- Q. UL 1072 – Medium-Voltage Power Cable

1.5 SUBMITTALS

- A. Product Data: For each type of cable indicated. Include splices and terminations for cable and cable accessories.
 - 1. Include cable drawings with the following data:
 - a. Longitudinal cutback and cross-sectional view of cable.
 - b. Identification and structure of cable components.
 - c. Dimensions of cable components in English and SI units.
 - 2. Contractor shall furnish cable manufacturer's catalog cut sheets and written statements from the manufacturer for the specific cable to be furnished that shall include the following information:
 - a. Conductor size and stranding.
 - b. Type and thickness of the semi-conducting shield.
 - c. Type and thickness of insulation.
 - d. Type and thickness of insulation shield.
 - e. Type and thickness of jacket.
 - f. Diameter of the insulated, shielded cable and variations from the average O.D. due to production.
 - g. Diameter of the single cable including the jacket.
 - h. Diameter over the insulation for single cable.
 - i. Recommended minimum bending radius, single conductor.
 - j. Manufacturer's recommendation for:
 - k. Maximum pulling tension with conductor pulling eye and cable grip.
 - l. Maximum sidewall pressure.
 - m. Cable manufacturer's name and location of plant at which cable will be produced.
 - n. Manufacturer's warranty for cable offered.
- B. Warranties: Cable material warranties shall be 30 years. Other warranties shall be per Division 1 requirements.
- C. Material Certificates: For each cable and accessory type, signed by manufacturer.
- D. Manufacturer Testing Certificate: For each type and voltage class of cable indicated.
- E. Certified Field Quality Control Test Reports per requirements in Section 26 08 12 – Power Distribution Acceptance Tests for each type and voltage class of cable indicated. Indicate applicable standards compliance. Interpret test results and corrective action taken for compliance with specification requirements.
- F. Qualification Data: For installer and testing agency.

- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

- H. Installation Guide: Include the following:
 - 1. Maximum allowable pulling tension (in pounds and newtons)
 - 2. Minimum allowable bending radius
 - 3. Recommended pulling compounds
 - 4. Splicing and termination instructions with diagrams, dimensions, and material lists
 - 5. Weight per 1,000 ft
 - 6. Standard "packaging" of reels (i.e., lengths, lagging, banding, etc.)
 - 7. Reactance and AC resistance (ohms to neutral) of each size and voltage class of cable, both in magnetic and non-magnetic duct, based on 3-1/C cables or 1-3/C cable in one duct.

- I. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of cables, splices, and terminations.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.6 QUALITY ASSURANCE

- A. Installer:
 - 1. C10 electrical contractor's license.
 - 2. All employees of the C10 electrical contractor will hold a valid "State Certified General Electrician" card issued by the California Department of Industrial Relations' Division of Apprenticeship Standards.
 - 3. Person(s) performing medium voltage terminations will possess a certification indicating that they have attended formal training on splicing and terminating medium voltage cables in the types of terminations being performed. Successful completion of the course and examination will be provided to the University prior to the start of any work.
 - 4. Person(s) performing medium voltage work or installation will have at least 5 years of verifiable experience performing such work. Submit a record of employment or projects for the University to review and approve.
 - 5. Experience records of cable splicers/handlers shall include educational or special instruction courses attended for splicing and any certifications issued by cable manufacturers. Splicing experience shall include a minimum of 5 years of experience as a journeyman cable splicer, with dates and jobs listed. No one shall be permitted to splice or terminate medium voltage cable prior to Owner having

reviewed the qualifications of the cable splicer. Contractor shall provide Owner, in writing, compliance with these Specifications. All electricians including cable splicers shall have general electrician certification required by the California Division of Apprenticeship Standards.

- B. Regulatory Requirements:
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- C. Source Limitations: Obtain cables and accessories through one source from single manufacturer.
- D. All cables shall be of a single type and configuration. Date of manufacture shall not precede contract date by more than one year.
- E. DC proof testing, labeling, and phasing after cable is installed, spliced and terminated, and before energizing in accordance with Section 26 05 53.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate with manufacturer to provide protective covering over cable and reel to prevent damage during shipping, storage, or handling.
- B. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 SERVICE CONDITIONS

- A. The design and construction of the completed cables shall be such that they will operate satisfactorily at conductor temperatures not exceeding the following, at the hottest portion of the circuit at any time:

Type of Operation		Temperature
Normal		105°C
Emergency Overload		140°C
Short Circuit		250°C (482°F)

- B. The normal or continuous rating is based on 100% load factor, 40°C ambient temperature, and soil thermal resistivity of 105°C-cm/watt. The cable shall be capable of meeting the cumulative overload duration of 1500 hours during the lifetime of the

cable. The short circuit rating is based on the highest temperature attained by any part of the cable during a short circuit having a duration of 2 seconds, or less.

- C. The cable furnished under these Specifications shall be suitable for installation in underground ducts, conduits, and conduit risers (plastic, steel, or concrete), and for direct burial.
- D. The cable shall be suitable for operating both in wet and dry locations and in installations with alternate wet and dry conditions. Under wet conditions, alkaline liquid may be present.
- E. The cable may be located in areas where atmospheric ozone concentrations up to a maximum of one ppm may be present for extended periods through the year.
- F. The minimum temperature at the time of installation may be considered as being above freezing.

1.9 WARRANTY

- A. Manufacturer shall provide 30 year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Terminations and splices:
 - 1. Quick-Term molded rubber termination kit to make the 8kV stress-cone-type termination; Kit No. 7625-T-110 or 7622-T-110 7655-S-4 from Minnesota Mining Manufacturing Co. (3M) or Owner-approved equivalent from Raychem.
 - 2. Arc-proofing tape: Scotch #7700 or Tomic #43A.
 - 3. Pressure-sensitive glass cloth tape, minimum 1/2 in. wide: Scotch #27 or Tomic #77T.
 - 4. 200A/600A, 15 kV loadbreak elbows and inserts: Elastimold.
 - 5. Preformed rubber boot with nylon type bolts from Myers Products or General Electric.
 - 6. 15kV and 5 kV silicone rubber splice kits: QS-III cold shrink splice kit No. 5418-1000 from 3M or Owner-approved from Raychem.
 - 7. Hand Taped Splice Kits and materials supplied by 3M.
- B. Medium voltage cable:

1. The medium voltage power cable shall have a performance record demonstrating a minimum of thirty-five (35) years successful operating in utility and industrial power cable applications.
2. Acceptable Manufacturers:
 - a. Okonite
 - b. Southwire

2.2 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
- D. Conductor Stranding: Compact round, concentric lay, Class B
- E. Strand Filling: Conductor interstices are filled with impermeable compound
- F. Conductor Insulation: Ethylene-propylene-rubber
- G. Voltage Rating: 15 kV
- H. Insulation Thickness: 133 percent insulation level
- I. Shielding: Copper tape, helically applied over semiconducting insulation shield
- J. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket
- K. Cable Jacket: Sunlight-resistant PVC. Color: black, unless otherwise designated
- L. Cables utilizing combination insulation shield and jacket are acceptable.
- M. Cable lengths shall be supplied with factory-installed, moisture-proof end seals on conductors on each end. Cable seals shall be rubber or plastic caps, and shall prevent moisture from seeping into cable ends.
- N. Each cable reel shall be tagged with the following:
 1. Manufacturer
 2. Cable Size
 3. Cable Type
 4. Voltage Class
 5. Manufacture Date
 6. Cable Length

7. Tolerances
 8. Reel Number
 9. Customer Order No.
 10. Customer Name
- O. Surface Marking:
1. Cables shall be permanently printed (or imprinted) on jacket surface at regular intervals over entire length of cable with the following:
 - a. Manufacturer's name
 - b. Conductor size
 - c. Voltage class
 - d. Insulation type
 - e. UL designation
- P. Cables shall be constructed and rated for continuous and intermittent submersion in water and shall be suitable for installation in conduit and underground duct.
- Q. Cable shield shall be capable of withstanding fault current indicated on drawings for 1/10 second.

2.3 SPLICE KITS

- A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for application. Splicing is only permitted where shown on the construction documents. No other splicing will be permitted.
- B. Splice and termination kits shall be approved by the University. The University shall be notified 72 hours in advance so that they may observe each splice or termination being made.
- C. No below grade splicing is permitted.
- D. Splices in manholes: Provide only 15 kV 600 amp or 200 amp load-break elbows and connectors. No hand-taped splices are allowed unless specifically shown on plans.
- E. 15 kV and 5 kV switchgear: Provide high compression, two-hole long barrel type lugs, 15 kV or 5 kV termination kit, and cover with preformed rubber boot with nylon type bolts.
- F. Splicing Products: Where splicing is permitted per the plans and University approval it shall be completed using separable connectors. See Section 2.4 Separable Insulated Connectors.

2.4 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. Load-Break Cable Terminators: Elbow-type units with 15 KV class, 95 KV BIL load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated, with steel-reinforced hook-stick eye, grounding eye, and arc-quenching material. Include capacitance coupled test point on terminator body. Include cold shrinkable metallic shield adapter kit to ground metallic shielded cable. Include connection bus with parking stand for wall mounting.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600A 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.
- E. Dead-Front Terminal Junctions: 15 KV class, 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.
- F. Test-Pont 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.

- G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.5 ARC-PROOFING MATERIALS

- A. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3" thick, compatible with cable jacket.
- B. Glass-Cloth Tape: Pressure-sensitive adhesive tape, 1/2" wide.

2.6 FAULT INDICATORS

- A. Indicators: Automatic reset fault indicator arranged to clamp to cable sheath and provide a display after 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. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.
- C. SEL Automatic reset fault indicators to be connected to campus SCADA system

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to Section 26 08 12 – Power Distribution Acceptance Tests and Section 26 08 13 – Power Distribution Acceptance Test Tables.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Submit pull tension calculation based on the as built conditions of the conduct systems for University review and approval prior to cable installation. Pull tensions and side wall pressure must not exceed 90% of manufacturers maximum published limits.
- C. Pull Conductors: Do not exceed manufacturer's recommended minimum installation temperature, maximum pulling tensions, and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
 - 2. 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.

3. Cut off cable damaged by cable grips or pulling make-ups so as to provide clean, undamaged cable for termination. Continuously record pulling tension during installation.
 4. Notify University 72 hours prior to the installation of MV cables.
 5. Monitor cable installation tension using direct tension measurement device on the pulling cable/rope with a device that has been calibrated within 1 year. Provide report detailing force applied to the cable at 5' increments. Under no circumstances will cable be accepted if manufacturers pulling tension has been exceeded.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables in handholes and manholes from walls on heavy-duty, non-metallic cable rack arms, at least 3" above the floor. Support cables with reinforced nylon cradles. Anchor to wall with stainless steel anchor bolts.
1. Install compression connectors with hydraulic compression tool on 600V neutral/ground conductor.
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by longest route from entry to exit and support cables at intervals adequate to prevent sag. Fill lowest ducts first, avoid covering or blocking duct entrances and allow space for future cable installation. Retain one of two options below.
- G. Provide at least one 360-degree loop around first and last manhole for each cable run and every third manhole in between (if applicable).
- H. Cut cable in clean, dry environment. Seal cut ends with waterproof seal immediately after cutting. Maintain a seal during and after pulling.
- I. Install terminations at ends of conductors and seal multi-conductor cable ends with standard kits. Do not install exterior terminations during inclement weather or damp atmospheric conditions.
- J. Install stress cones at cable splices and terminations, grounded per cable and connector manufacturer recommendations.
- K. Check phase rotation before connections are made to existing circuits. Clearly letter cable terminations. Identify phases with phase designations lettered on terminal boxes and other terminations throughout the system.
- L. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected
 2. Portable Feed-Through Accessory: Three
 3. Standoff Insulator: Three
- M. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape and/or manufacturer's written instructions, apply arc proofing as follows:
1. Clean cable sheath.
 2. Wrap metallic cable components with 10 mil pipe-wrapping tape.
 3. Smooth surface contours with electrical insulation putty.
 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 5. Band arc-proofing tape with 1"-wide bands of half-lapped, adhesive, glass-cloth tape 2" o.c.
- N. Seal around cables passing through fire-rated elements according to Section 26 05 93 – Electrical Systems Firestopping.
- O. Install fault indicators on each phase where indicated.
- P. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware. For grounding requirements, refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- Q. Identify cables according to Section 26 05 53 – Electrical Systems Identification.

3.2 FIELD QUALITY CONTROL

- A. Perform cable acceptance tests on cable circuits after installing cables and before electrical circuitry has been energized. Splices and terminations required as part of this project are to be completed and acceptance tested as part of cable tests. For cables not spliced or terminated as part of project, ends should be clean, dry and long enough to eliminate leakage from conductor to ground along outer surface of cable.
- B. Perform acceptance tests and damage investigations under constant supervision of Owner's representative. Contractor shall coordinate and provide labor, material, equipment, and services necessary to test each completed cable circuit.
- C. Remove and replace defective cables and retest as required.
- D. Cable passing acceptance testing shall be placed into service not more than 72 hours after acceptance by University.

- E. Refer to Section 26 08 12 – Power Distribution Acceptance Tests for visual and mechanical inspection and electrical tests. Certify compliance with test parameters.

3.3 WARRANTIES

- A. Cable furnished under these Specifications shall be guaranteed against defective materials and workmanship for a period not less than 40 years from date of initial energization of system and shall include labor and travel time for necessary repairs at job site.

END OF SECTION 26 05 13.16

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems
- B. Section 26 05 33 - Surface Metallic Raceway System
- C. Section 26 05 53 - Electrical Systems Identification
- D. Section 26 05 93 - Electrical Systems Firestopping
- E. Section 26 08 12 - Power Distribution Acceptance Tests
- F. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations rated 600 V and less, sleeves and sleeve seals for cables.
- B. Conductor and conduit sizes in these contract documents are based on copper wire, and only copper wire shall be used.

1.4 REFERENCE STANDARDS

- A. ASTM B 1 – Standard Specification for Hand-Drawn Copper Wire.
- B. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. NEMA WC 70 – Non-Shielded Power Cable 2000 V or less for the Distribution of Electrical Energy (ICEA S-95-658).
- D. NFPA 70 – National Electrical Code.

- E. UL 44 – Thermoset-Insulated Wires and Cables.
- F. UL 83 – Thermoplastic-Insulated Wires and Cables.
- G. UL 486A-486B – Wire Connectors.
- H. UL 486C – Splicing Wire Connectors.
- I. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
- J. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- B. Wire and cable boxes and reels shall bear the date of manufacture.
 - 1. Date of manufacture shall not precede contract date by more than one year.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.7 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General Cable Corporation

- B. Cerrowire
- C. Southwire Company
- D. or equal
- E. VFD Cable: Aetna Insulated Wire, Americable, General Cable, Southwire or equal

2.2 DESCRIPTION

- A. NEMA WC 70; single copper conductor insulated wire; 600 V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.
 - 1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THWN .
 - 2. Thermoset-insulated wires and cables: NEMA WC 3, UL 44; Type XHHW.
- B. All conductors will be manufactured in their corresponding phase color identifiers. The use of phase tape or other means is not acceptable.
- C. All conductors #16 AWG and larger are to be stranded conductors.
- D. VFD Cable:
 - 1. Cable
 - a. 600V/2000V rated, high stranded tinned copper conductors, shielded, engineered for use with Variable Frequency Drives.
 - b. Insulation shall be rated for 90 degrees Celsius Wet/Dry operating temperature.
 - 2. Conductors
 - a. Conductor shall be annealed fine wire flexible high strand count tinned copper or standard Class B stranded bare copper.
 - b. Three (3) phase conductors, three (3) ground conductors. Each of the three ground conductors shall be the same size as the single ground conductor shown on the drawings.
 - 3. Insulation
 - a. Flame-Retardant Cross-Linked Polyethylene.
 - b. Conductors shall be cabled together. Ground conductors shall be symmetrical. Fillers shall be included as necessary to make the cable round.
 - 4. Shielding
 - a. The following are acceptable:
 - 1) Overall tinned copper braid plus aluminum/polyester tape foil, 100% coverage.
 - 2) 5mil helically applied copper tape.
 - 3) Impervious corrugated welded continuous armor.

5. Jacket
 - a. Flame-retardant Thermoplastic, suitable for 90°C use.
6. Termination Kit
 - a. Pre-sized and pre-formed specifically for VFD cable constructions. Obtain from VFD cable manufacturer.

2.3 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Class 1
 1. Copper conductor, single insulated wire.
 2. Insulation type THHN-2 rated 90°C, 600 V insulation class.
 3. Type XHHW for ambient temperature less than 32°F.
 4. ASTM B 8 for stranded conductors. #16 AWG and larger to be stranded conductors.
- B. Classes 2 and 3
 1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
 2. Insulation type XLEP, rated 105°C, 300 V insulation class.
 3. UL listed for use in space in which circuits will be installed.

2.4 CONNECTORS, SPLICES, AND TERMINALS

- A. Manufacturers:
 1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division
 5. Tyco Electronics Corp.
 6. Or equal
- B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.5 TERMINATIONS

- A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.
- B. Insulation piercing terminations are not permitted.
- C. "Wago" or similar type of termination devices are not permitted.

2.6 PLASTIC CABLE TIES

- A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install conductors in a raceway system, unless otherwise specified or indicated.
- B. Install conductors only after:
 - 1. Building interior is enclosed and weather tight
 - 2. Mechanical work likely to damage conductors has been completed
 - 3. Raceway installation is complete and supported
- C. Pull conductors into raceway at same time.
- D. Neatly train and lace conductors inside boxes, equipment, and panelboards.
- E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- F. 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.
- G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. Protect exposed cables from damage.
- I. Support cables above accessible ceiling using plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
- J. Support cables and conductors in vertical raceways per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.
- K. Identify and color-code conductors and cables according to Section 26 05 53 - Electrical Systems Identification.
- L. Wiring at Outlets: Install conductor at each outlet, with minimum 6" of slack.

- M. Limit conduit fill to a maximum of 9 current-carrying conductors provided that derating portion of the NEC is met.
- N. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.
- O. Install VFD input wiring, output wiring and control wiring in their own separate conduit systems.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Stranded for #16AWG and larger conductors.
- B. Branch Circuits: Copper Stranded for #16 AWG and larger conductors.
- C. Minimum conductor sizes shall be as follows:
 - 1. #12 AWG – Branch circuits of any kind.
 - 2. #14 AWG – Fire alarm system.
 - 3. #16 AWG – Remote control and signal systems.
- D. Branch wiring length limitations:
 - 1. 208Y/120 V circuits over 100' in length: Increase wire size one size for each 100' of length. Increase conduit size as required.
 - 2. 480Y/277 V circuits over 150' in length: Increase wire size one size for each 150' of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Provide type THWN or THHN-2 wire and cable #4/0 AWG size and smaller in dry locations. Provide type THWN-2 wire and cable larger than #4/0 AWG size in wet locations. All conductor sizes shall be fully rated for the entire length of the feeder run. Conductors oversized for voltage drop may be reduced near the end of a conductor to allow termination at devices. Tap conductors from main feeder shall be reduced and allowed by the code.
- B. Motor Circuit Branch Wiring Between Motor and VFD: VFD Cable
 - 1. Terminate VFD cable using pre-sized and pre-formed termination kits supplied by cable manufacturer. Install per manufacturer's recommendations.
- C. Branch Circuits Single Conductors in Raceway: 90°C rated conductors sized at 75°C rating for connection to equipment and devices.

3.4 REMOTE CONTROL AND SIGNAL CIRCUITS

- A. Sizing – #16 AWG minimum.
- B. Installation:
 - 1. Install cables in cable tray and cable rings.
 - 2. Provide protection for exposed cables where subject to damage.
 - 3. Support cables above accessible ceilings; do not rest on ceiling tiles.
 - 4. Use suitable cable fittings and connectors.

3.5 CONNECTORS, SPLICES, AND TERMINALS

- A. Connectors:
 - 1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
 - 2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat- shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.
 - 3. Use pre-insulated "twist-on" connectors with integral spring for splices and taps of #10 AWG conductors and smaller.
 - 4. 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.
 - 5. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
 - 6. Wago or other types of push in connectors are not permitted.
- B. Splices:
 - 1. Splice wires and cable only in accessible locations such as within junction boxes.
 - 2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
 - 3. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat- shrinkable insulating tubing, or resin-filled insulator.
 - 4. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
 - 5. Plastic snap-on splice insulators are not allowed.
 - 6. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 7. Wago or other types of push in connectors are not permitted.

- C. Terminals:
 - 1. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
 - 2. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
 - 3. Train wires to eliminate fanning of stands, crimp with proper tool and die.
 - 4. Torque screw termination per manufacturer's recommended values.

3.6 CABLE TIES

- A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.7 FIELD QUALITY CONTROL

- A. Test 600 volt conductors and cables per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 08 13 – Power Distribution Acceptance Test Tables.
- B. Interpret test results in writing and submit to Owner's Representative.
- C. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 43 - Ducts and Raceways for Electrical Systems
- B. Section 26 08 12 - Power Distribution Acceptance Tests
- C. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.
- B. Maximum resistance to ground shall be less than 5 ohms.
- C. Refer to Grounding Riser Diagram.

1.4 REFERENCE STANDARDS

- A. ASTM B 3 – Specification for Soft or Annealed Copper Wire
- B. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
- C. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
- D. IEEE C2 – National Electrical Safety Code (ANSI)

- E. IEEE 857 – Standard for Qualifying Permanent Connections Used in Substation Grounding
- F. NETA MTS – Maintenance Testing Specifications
- G. NFPA 70 – National Electrical Code
- H. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
- I. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Test wells
 - 2. Ground rods
 - 3. Ground rings
 - 4. Grounding arrangements and connections for separately derived systems
 - 5. Grounding for sensitive electronic equipment
- C. Field Quality-Control Test Reports:
 - 1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
 - 2. Test reports of resistance to earth. Each test report shall include:
 - a. Date of test, soil moisture content, and soil temperature
 - b. Test operator
 - c. Instrument or other test equipment used
 - d. Electrode designation or location
 - e. Ground impedance in ohms
 - f. Assumptions made - if required
- D. Closeout Submittals:
 - 1. Operation and Maintenance Manuals: Include the following:
 - a. 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) Instructions to perform tests to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
 - 2. Comply with UL 467 for grounding and bonding materials and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 – General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of #17 AWG conductor, 1/4" in diameter.
 - 5. Bonding Conductor: #4 AWG or #6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8" wide and 1/16" thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8" wide and 1/16" thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. #4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

- D. Grounding Bus: Horizontal rectangular bars of annealed copper, 3/8" by 4" in cross section; with insulators as indicated on drawings.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Electro-tin plated copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Compression Connectors: Irreversible type.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4" in diameter by 10 ft in length.

Table 1 –TBB conductor size vs length

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Stranded conductors for #16 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor. No. #4/0 AWG] minimum.
 - 1. Bury at least 24" below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with 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.
- D. Grounding Bus: Install in electrical and communications rooms, in rooms housing service equipment.
 - 1. Install bus on insulated spacers 1", minimum, from wall; 6" above finished floor.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor, and connect to horizontal bus.
- E. 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

3.2 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" will extend above finished floor. If necessary, install ground rod before manhole is placed and provide #4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof PVC 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" above to 6" below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, catch basins, metallic cover frame and cable

shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with #4 AWG minimum, solid, copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits. All connections to be made by non-reversible splicing methods. All fasteners located in manholes to be 316 stainless.

- 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 transformer and switches by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than #4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6" from the foundation.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with feeders and branch circuits.
 - 1. Install a single insulated equipment ground conductor for each branch circuit conduit originating from panelboards.
- 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
 - 7. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install a separate insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping. Ground ductwork of fans serving flammable liquid storage rooms or fume hoods. Install continuous ground around any flexible connections in this ductwork system. Bond lower end of exhaust ducts, vent stacks, etc., which pass through roof.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- E. Duplex receptacles of any amperage: Install separate jumper between grounding terminal on device and metallic box.
- F. 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.
- G. 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.
- H. Size of equipment grounding conductors for branch circuits: As indicated in NEC-70, except minimum size shall be #12 AWG.
- I. Size of branch panel feeder originating at switchboards/switchgear: As indicated in NEC-70, except in no instance smaller than #8 AWG.
- J. Signal and Communication Equipment: For alarm and other communication equipment (see Telecommunications Grounding System Installation section below for voice and data systems), install #4 AWG minimum grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4" x 2" x 12" grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- K. Install grounding conductor from each standby-emergency generator to grounding electrode system. Provide flexible jumper between base and isolated generator.
- L. Install equipment grounding conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.
- M. Install grounding for service entrance equipment room consisting of ground bus, ground conductors, and 5/8" x 10'-0" copperweld grounding rods arranged as indicated on drawings.

1. Ground bus shall be horizontal 3/8" x 4" copper bar. Bolt to wall at 10' intervals with 1" stand-offs at each bus support.
 2. Install ground bus per details on drawings.
- N. Install grounding conductor to luminaires hanging from conduit swivel hangers.
- O. Metal 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 to pole base. Grounding Conductor: Same size as phase conductors, but not smaller than #10 AWG.
1. Install at each pole or standard a concealed driven 1/2" x 8'-0" ground rod, ground clamp and No. 3 stranded copper conductor concealed and attached to pole and base.

3.4 SEQUENCING, SCHEDULING

- A. Permanently attach service grounds before permanent building service is energized.
- B. Permanently attach equipment grounds prior to energizing equipment.

3.5 INSTALLATION

- A. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.
- B. Identify all grounding conductors by system and room number of termination at building grounding electrode point.
- C. 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.
- D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96A 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.
- E. Ground Rods: Drive rods until tops are 2" 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.

- F. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12" deep, with cover.
 - 1. Test Wells: 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.
- G. 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 so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- H. 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, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, 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. Water pipe, by itself, is not an adequate grounding electrode and must be supplemented by another electrode system. Bond system together.
 - 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.
- I. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned copper bonding jumper to bond across flexible duct connections to achieve continuity.
- J. 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 apart.
- K. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

- L. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.
- M. 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 #4/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24" from building foundation and 30" below grade.
- N. Concrete-Encased Grounding Electrode: Fabricate according to NFPA 70, using a minimum of 20' of bare copper conductor not smaller than #4/0 AWG.
 - 1. If concrete foundation is less than 20' 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 grounding grid or to grounding electrode external to concrete.
- O. Equipment Grounding Conductor: Terminate in panelboard at green wire ground bus.
- P. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.
- Q. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

3.6 BONDING AND GROUNDING SYSTEM INSTALLATION

- A. Provide required elements and miscellaneous hardware necessary to establish Bonding and Grounding infrastructure as specified.
- B. Install products in accordance with manufacturer's instructions. Install Compression Connectors with compression, tool-and-die system, as recommended by manufacturer of connectors.
- C. Electrical Bonding Conductor, Electrical Bonding Backbone (TBB), and Grounding Equalizer (GE): Exothermic type connections.
- D. Locate TGBs and TMGB per drawings.
- E. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).

1. TGBs shall be bonded to TBB via tap off of TBB. Exception: "last" TGB on TBB (e.g., furthest from TMGB).
 2. Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.
- F. Insulate busbars from their support.
- G. All below grade grounding connections shall be made with exothermic welds.

3.7 FIELD QUALITY CONTROL

- A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
1. 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.
- B. Test grounding systems per requirements in Section 26 08 12 – Power Distribution Acceptance Tests and 26 08 13 – Power Distribution Acceptance Test Tables.
- C. Interpret test results in writing and submit to Engineer.
- D. Inspect completed system by commissioning authority, prior to backfilling.

END OF SECTION 26 05 26

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SECTION 26 05 29 - HANGERS AND SUPPORT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 33 – Raceway and Boxes for Electrical Systems
- B. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems
- C. Section 26 12 13 – Liquid-Filled, Medium-Voltage Transformers
- D. Section 26 12 19 – Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
- E. Section 26 13 16 – Medium-Voltage Fusible Interrupter Switchgear
- F. Section 26 13 19 – Medium-Voltage Vacuum Interrupter Switchgear
- G. Section 26 22 00 – Low-Voltage Transformers
- H. Section 26 23 00 – Low-Voltage Switchgear
- I. Section 26 24 13 – Switchboards
- J. Section 26 24 16.13 – Lighting and Appliance Panelboards
- K. Section 26 24 16.16 – Distribution Panelboards
- L. Section 26 28 16 – Enclosed Switches and Circuit Breakers
- M. Section 26 29 13 – Enclosed Controllers
- N. Section 26 32 13 – Engine Generators
- O. Section 26 36 23 – Automatic Transfer Switches
- P. Section 26 50 00 – Lighting

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes the following:
 - 1. Manufactured hangers and supports for individual raceways and cables, slotted channel and angle systems for multiple conduit runs, and most electrical equipment that is not floor mounted.
 - 2. Construction requirements for concrete housekeeping pads for floor-mounted electrical equipment.
 - 3. Conduit hangers for acoustical noise and vibration control.
 - 4. Heavy equipment support pads for acoustical noise and vibration control.
 - 5. Equipment mounts for acoustical noise and vibration control.

1.4 REFERENCE STANDARDS

- A. AWS D1.1/D1.1M – Structural Welding Code-Steel.
- B. ASTM A 36/A 36M – Carbon Structural Steel.
- C. ASTM A 325 – Structural Bolts, Steel, Heat Treated, 827/724 MPa(120/105 ksi) Minimum Tensile Strength.
- D. ASTM A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- E. MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.
- F. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.
- G. MFMA-4 – Metal Framing Standards Publication.
- H. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.
- I. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- J. NFPA 70 – National Electrical Code.
- K. SSPC-PA 1 – Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
- L. ETL PVC-001 – PVC Coated Conduit

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."

- B. Comply with NFPA 70.
- C. Certification
 - 1. Installer of PVC-coated hangers and supports shall be certified by a PVC conduit manufacturer.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of [5] [] times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Finishes
 - a. Metallic Coatings:
 - 1) Factory standard primed, galvanized or electroplated finish and applied according to MFMA-4, for indoor applications.
 - 2) Hot-dip galvanized after fabrication and applied according to MFMA-4, for outdoor applications.
 - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4, for corrosive environments.
 - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 2. Channel Dimensions: Selected for applicable load criteria.
 - 3. Manufacturers:
 - a. Allied Support Systems; Power-Strut Unit.
 - b. Cooper B-Line, Inc.; A division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corporation.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. National Pipe Hanger Corporation.
 - i. Michigan Hanger Co., Inc.; O-Strut Division.
 - j. or equal.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

- D. Raceway and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. PVC Raceway Support Devices: ANSI C80.1, UL6, ETL PVC-001.
- F. Support for Conductors in Vertical Raceway: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical 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 malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Concrete Anchors
 - a. Anchors shall be selected, sized, and detailed by Contractor's structural engineer registered in project's jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.
 - b. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.
 - c. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.
 - d. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.
 - e. Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 20 05 49 – Seismic Anchorage and Restraints and Structural drawings.
 - f. Anchors shall be zinc plated in accordance with ASTM B633.
 - g. Select anchors with load ratings based on cracked concrete conditions.
 - h. 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.
 - 1) Manufacturers:

- a) Hilti Inc.
 - b) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
 - c) MKT Fastening, LLC.
 - d) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit
 - e) Or equal
- i. 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 in which used.
 - 1) Manufacturers:
 - a) Cooper B-Line, Inc.; A division of Cooper Industries
 - b) Empire Tool and Manufacturing Co., Inc.
 - c) Hilti Inc.
 - d) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
 - e) MKT Fastening, LLC.
 - f) Or equal
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - I. Beam Clamps: C-clamps are allowed 3/8" or smaller and only for static loading such conduits. Provide locknut for hanging rod at clamp. C-clamps are not allowed for open web steel joist applications nor seismic applications.
 - J. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - K. Toggle Bolts: All-steel springhead type.
 - L. Hanger Rods:
 - 1. MSS SP-58; threaded steel, with adjusting and lock nuts; electroplated zinc finish.
 - 2. MSS SP-58; nonmetallic, with adjusting and lock nuts.

2.2 FABRICATED METAL FRAMING 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 Division 05 Section "Metal Fabrications" for steel shapes and plates; not be lighter than 12 ga.
- C. Finish: Electro-galvanized
- D. Manufacturers: Same as in paragraph 2.1.B.3 above.

2.3 CONTINUOUS INSERT CHANNELS

- A. Length and support capabilities to be suitable for application.
- B. Brackets, inserts and accessories suitable for channel insert selected.
- C. Manufacturers:
 - 1. Unistrut; Tyco International, Ltd.
 - 2. Cooper B-Line, Inc.; A division of Cooper Industries
 - 3. Michigan Hanger Co., O-Strut Division
 - 4. Anvil International, Inc.
 - 5. Or equal

2.4 CONDUIT HANGERS FOR ACOUSTICAL NOISE AND VIBRATION CONTROL

- A. Manufacturers:
 - 1. Mason Industries, Inc. (Hauppauge, NY), Type HD.
 - 2. Amber/Booth Co. (Houston, TX), Type BRD-A.
 - 3. Kinetics Noise Control, Inc. (Dublin, OH), Type RH or FH.
 - 4. Vibration Eliminator Co., Inc. (Long Island City, NY), Type 3C.
 - 5. Vibration Mountings & Controls, Inc. (Butler, NJ), Type RHD.
 - 6. Or equal
- B. HN (hanger neoprene) isolators shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck bushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. A pre-compressed glass fiber element may be substituted for the neoprene element.
- C. HN isolators shall be selected to achieve 1/10" minimum static deflection under load.

2.5 HEAVY EQUIPMENT SUPPORT PADS FOR ACOUSTICAL NOISE AND VIBRATION CONTROL

- A. Manufacturers:
 - 1. Mason Industries, Inc. (Hauppauge, NY), Type WSW or Super W.
 - 2. Amber/Booth Co. (Houston, TX), Type NR.
 - 3. Kinetics Noise Control, Inc. (Dublin, OH), Type NPS.
 - 4. Vibration Eliminator Co., Inc. (Long Island City, NY), Type 200N (Multilayers).
 - 5. Vibration Mountings & Controls, Inc. (Butler, NJ), Series Maxi-Flex.
 - 6. Or equal
- B. DNP (double neoprene pad) isolators shall be formed by layers of 1/4" to 3/8" thick (3/4" total thickness) ribbed or waffled neoprene. These layers shall be permanently

adhered together. The pads shall have a galvanized steel load bearing plate on top to distribute the load over the entire surface of each pad. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.

2.6 EQUIPMENT MOUNTS FOR ACOUSTICAL NOISE AND VIBRATION CONTROL

- A. Manufacturers:
1. Mason Industries, Inc. (Hauppauge, NY), Type ND.
 2. Amber/Booth Co. (Houston, TX), Type RVD.
 3. Kinetics Noise Control, Inc. (Dublin, OH), Type RD.
 4. Vibration Eliminator Co., Inc. (Long Island City, NY), Type D44.
 5. Vibration Mountings & Controls, Inc. (Butler, NJ), Series RD.
 6. Or equal
- B. FN (floor neoprene) isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
- C. FN isolators shall be selected to achieve 1/10" minimum static deflection under load.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with 2-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 3/4" and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Install PVC-coated hangers and supports in areas with corrosive atmosphere.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in paragraphs below.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. 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.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor application size and placement shall be reviewed and approved by Structural Engineer prior to installation. 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. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4" thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4" thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. 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 meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Do not support raceway by other raceway.
- G. Do not support equipment or raceway from metal roof decking or floor decking.

- H. Do not impose weight of electrical equipment, raceways, or lighting fixtures on support provided for other trades or systems.
- I. Top or bottom chords of open web steel joists may be used to support loads provided total load within panel does not exceed 100 lbs and load is placed concentric to joist (panel is length of chord between two adjacent diagonal web members at point of connection to chord).
 - 1. C-clamps are not permitted for use in open web steel joist applications.
- J. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.
- K. Use conduit-mounting pedestals for piping on roof. Install bottom of pedestal flat on roof deck and insulate exterior of pedestal, flush and counter flush.
- L. Minimize use of concrete anchors and inserts after concrete pour.
- M. Punching, drilling, welding of building structural steel or welding attachment to building structural steel is not allowed, unless approved by structural engineer.
- N. Use tools approved for use with PVC-coated conduits and fittings.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "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.

3.4 CONCRETE HOUSEKEEPING PADS

- A. Construct concrete housekeeping pads for all floor-mounted electrical equipment.
- B. Dimensions: 4" high and not less than 4" larger in both directions than supported equipment, so anchors will be a minimum of 10 bolt diameters from edge of the base.
- C. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Anchor equipment to concrete housekeeping pad.

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.
- E. Coordinate with Owner's Representative installation of housekeeping pads on roof.

3.5 PAINTING

- A. Touchup: 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.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 Section "Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing- repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- E. Section 26 05 53 - Electrical Systems Identification
- F. Section 26 27 26 - Wiring Devices

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes raceways, fittings, wireways, wall ducts, indoor service poles, outlet boxes, pull and junction boxes, floor boxes, tap boxes and raceway seals.

1.4 REFERENCE STANDARDS

- A. ANSI/NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting
- B. ANSI C80-1 - Rigid Steel Conduit-Zinc Coated (GRS)
- C. ANSI C80-3 - Electrical Metallic Tubing-Zinc Coated (EMT)
- D. ANSI C80-5 - Aluminum Rigid Conduit-Zinc Coated (ARC)
- E. ANSI C80-6 - Intermediate Metal Conduit-Zinc Coated (IMC)
- F. ASTM A 53/A 53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

- G. BICSI TDMM - Telecommunications Distribution Methods Manual, Latest Edition
- H. ETL PVC-001 - PVC-Coated Conduit
- I. NEMA 250 - Enclosures for Electrical Equipment (1000 V Maximum)
- J. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
- K. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
- L. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports
- M. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- N. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
- O. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- P. NFPA 70 - National Electrical Code
- Q. TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces
- R. UL 1 - Flexible Metal Conduit
- S. UL 6 - Electrical Rigid Metallic Conduit-Steel
- T. UL 6A - Electrical Rigid Metallic Conduit-Aluminum and Stainless Steel
- U. UL 360 - Liquid-Tight Flexible Steel Conduit
- V. UL 514A - Metallic Outlet Boxes
- W. UL 514B - Conduit, Tubing, and Cable Fittings
- X. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
- Y. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings
- Z. UL 797 - Electrical Metallic Tubing-Steel
- AA. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings
- BB. UL 1242 - Electrical Intermediate Metal Conduit-Steel

CC. UL 2024 - Optical Fiber and Communication Cable Raceway

1.5 SUBMITTALS

- A. Product Data:
 - 1. Floor boxes
- B. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.
- C. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual routing of raceways larger than 2".
 - b. Record actual location and mounting heights of wireways, wall ducts, indoor service poles, floor boxes, tap boxes, outlet, pull and junction boxes.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with NFPA 70.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- B. Certification:
 - 1. Installer of PVC-coated conduits and fitting shall be certified by a PVC conduit manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Protect PVC conduit from sunlight.
- C. Comply with manufacturer's written instructions.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 UNIVERSITY STANDARDS

- A. Raceway methods and selections that meet campus standards:
 - 1. All fittings used in the assembly of raceways are to be of the "steel type". Die cast fittings are not acceptable.
 - 2. Die Cast condulets are not acceptable. Provide Form 7 Cast Iron or Form 7 Aluminum condulets where condulets are required. Condulets must be installed in accessible locations.
 - 3. The use of "factory fittings" for EMT, IMC and Rigid pipe is not acceptable. All conduits will be field bent and cut to fit using field tools and equipment. PVC factory elbows and fittings are acceptable were PVC has been determined to be an acceptable raceway.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC)

- A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel
- B. Rigid Aluminum Conduit (RAC): ANSI C80.5; heavy wall aluminum
- C. PVC coated rigid steel conduit: NEMA RN 1, ANSI C80.1, UL 6, ETL PVC-001; plastic cap protector caps
- D. Fittings (couplings, conduit bodies, connectors and bushings): NEMA FB 1, UL 514B; steel; threaded; connectors with double locknuts and steel insulating bushings, thermoplastic insulating bushings for conduits 2" and smaller; conduit bodies cover: steel, with stainless steel screws and neoprene gaskets; PVC coated to match conduit.
- E. No die cast bodies are acceptable.
- F. Fittings Manufacturers: Cooper Crouse-Hinds; Carlon Electric Products/Prime Conduit Inc.; O- Z/Gedney; Appleton; Hubbell or equal;

- G. All condulets shall be cast iron. The use of die cast fittings is not acceptable.

2.2 ELECTRICAL METALLIC TUBING (EMT)

- A. ANSI C80.3, UL 797; galvanized steel tubing
- B. Fittings (couplings, conduit bodies, and connectors): NEMA FB I, UL 514B; steel, watertight gland compression type connectors with double locknuts and insulated throat; conduit bodies cover: steel, with stainless steel screws and neoprene gaskets. Indentor, drive-on, die-cast or pressure cast fittings not permitted.
- C. Fittings Manufacturers: Same as manufacturers listed in 2.1.F.

2.3 FLEXIBLE METAL CONDUIT (FMC)

- A. UL 1; interlocked steel
- B. Fittings: NEMA FB I, UL 514B; steel

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. UL 360; interlocked steel, with PVC jacket
- B. Fittings: NEMA FB 1, UL 514B; steel

2.5 RIGID NONMETALLIC CONDUIT (RNC)

- A. NEMA TC 2, UL 651; Schedule 40 PVC
- B. Fittings: NEMA TC 3, UL 651

2.6 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A; galvanized steel with stamped knockouts.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; 1/2" male fixture studs, where required.
 - 2. Concrete Ceiling Boxes: Concrete type
- B. Cast-Metal Outlet Boxes: NEMA FB 1, Type FD, with gasketed cover
 - 1. For applications requiring more than 2 gang boxes, provide stainless steel custom fabricated welded boxes with threaded hubs and coverplate. For applications including terminations and splicing of power conductors, a standard UL Listed box shall be used inside of the custom fabricated box.]

- C. Nonmetallic Outlet Boxes: NEMA OS 2
- D. Gangable type boxes are not allowed.
- E. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds or equal;

2.7 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1; galvanized steel
- B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1; galvanized, cast iron with ground flange, gasketed cover and stainless-steel cover screws
- C. Minimum size: 4" square by 2-1/8" deep for use with 1" conduit and smaller; 4-11/16" square by 2- 1/8" deep for use with 1-1/4" conduit and larger
- D. Sheet Metal Boxes Larger Than 12" in any direction: Hinged cover or a chain installed between box and cover
- E. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.
- F. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds or equal;

2.8 POKE-THROUGH FITTINGS

- A. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
 - 1. Fire Rating: 3h
 - 2. Service Fitting Type: Flush
 - 3. Manufacturers: Hubbell, Legrand/Wiremold, FSR or equal;

2.9 FLOOR BOXES

- A. Metal Floor Boxes: NEMA OS1; cast metal and sheet metal; fully adjustable; rectangular; Moisture- proof, with forged brass blank cover with each box and close up covers and/or carpet flanges as required for finished floor.

2.10 MULTISERVICE FLOOR BOXES

- A. Above Grade: Stamped steel, watertight design approved for use on above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication services. The box: fully adjustable providing pre-pour and after- pour adjustment, tunnel compartment, and

two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.

- B. On Grade: Cast iron or steel pour box, watertight design approved for use in on-grade and above- grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication devices. The box: fully adjustable providing pre- pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.
- C. Covers: Activation Covers - Die-cast aluminum with textured aluminum finish, and black or brass powder-coated paint finishes as selected by the Owner's Representative. Cover: flanged or flangeless, as required, with options for tile or carpet inserts, blank covers, or covers with one or two 1" liquid tight conduit openings for furniture feed applications.
- D. Communication Modules Mounting Accessories: Complete line of faceplates and bezels provided by floor box manufacturer to facilitate mounting of fiber optic, coaxial, high-performance twisted- pair cabling, and communication devices. Cabling type and faceplate configurations per requirements in Section 27 15 00 - Communications Horizontal Cabling. The box shall accommodate workstation connectivity outlets and modular inserts and other system devices.
- E. Manufacturers:
 - 1. Hubbell - HBLCFB Series
 - 2. Spider - AFB/CFB Series
 - 3. Legrand/Wiremold - Evolution Series
 - 4. Or equal

2.11 TAP BOXES

- A. Multi-tap connectors as indicated on drawings.
- B. Manufacturers: IlSCO;

2.12 EXPANSION FITTINGS

- A. Malleable iron, hot dip galvanized allowing 4" (± 2 ") raceway movement.
- B. Manufacturers: OZ/Gedney AX Series; or equivalent by manufacturer listed in 2.1.F.

2.13 RACEWAY PENETRATION SEALS

- A. Thruwall and Floor Seals.
- B. Manufacturers: New construction - OZ/Gedney FSK Series; existing construction - OZ/Gedney CSM Series; or equivalent by manufacturer listed in 2.1.F.

2.14 RACEWAY SEALING FITTINGS

- A. For one through four conductors: Manufacturers: OZ/Gedney CSB Series;
- B. For greater than four conductors: Manufacturers: OZ/Gedney EYA Series with sealing compound;
- C. Low-temperature or hazardous locations: Manufacturers: OZ/Gedney EYA Series with sealing compound;

2.15 CABLE SUPPORTS

- A. Manufacturers: OZ/Gedney Type S; or equivalent by manufacturer listed in 2.1.F.

2.16 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with integral water stop.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052" or 0.138" thickness and of length to suit application.
- C. Integral Water Stop: Manufacturer: Thunderline Corporation;
 - 1. Steel. Type WS engineered sleeve.

2.17 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 2. Pressure Plates: Plastic. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate with Owner's Representative size and location of required built-in openings in building structure, including those sleeved, formed or core drilled.
- B. Coordinate with Owner's Representative cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.
- C. Verify with Owner's Representative all surface raceway installations except in mechanical, electrical, and communications rooms.
- D. Coordinate with Owner's Representative exact locations of floor boxes, where shown on drawings, prior to rough-in.
- E. Coordinate routing of through-roof conduits.
- F. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 05 93 - Electrical Systems Firestopping.
- G. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.
- H. Verify with manufacturer that "touch-up" paint kit and PVC-coating kit are available for use.

3.2 EXAMINATION

- A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway's installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION - For additional information See Section 3.4 Application

- A. Raceways:
 - 1. Comply with ANSI/NECA 1 and NFPA 70 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.
 - 2. Arrange raceways to maintain headroom and present neat appearance.
 - 3. Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation.
 - 4. Keep raceways at least 12" away from parallel runs of fuels, steam, hot-water pipes or ductwork. Install horizontal raceway runs above water and steam piping.

Install raceways level and square and at proper elevations: 6'-6" minimum headroom, except in exit pathways 7'-0" minimum headroom. Do not block access to junction boxes, mechanical equipment or prevent removal of ceiling panels, etc.

5. Run raceways concealed in construction to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid materials and equipment of other trades, except where noted otherwise.
6. Avoid exposed raceway runs. Run raceways exposed where impractical or impossible to conceal or where specific approval is obtained. Run exposed raceways grouped and parallel or perpendicular to construction. Do not route exposed raceways over boilers or other high- temperature machinery or in contact with such equipment. Offset exposed raceways at boxes.
7. Route raceways installed above accessible ceilings parallel or perpendicular to construction.
8. Do not install raceways in structural or topping floor slabs, except where noted on the plans. Install raceway in structural or topping floor slabs, where noted on plans, as follows:
 - a. Center raceways in structural slabs clear of reinforcing steel, except where crossing same, and spaced on centers equal or exceeding 3 times the raceway diameter. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in concrete.
 - b. Outside diameter of raceway shall not exceed 12".
 - c. Obtain approval from Owner's Representative for each run of raceway 1" or larger.
 - d. Do not install raceways in topping slabs of 2" or less.
 - e. Locate raceways to avoid conflict with equipment, door bucks, partitions and other equipment bolted to floor.
 - f. Arrange stub-ups so curved portions of bends are not visible above finished slab. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; use flexible metal conduit 6" above the floor. Install threaded plugs flush with floor for future equipment connections.
 - g. Change from nonmetallic raceway to RMC before rising above floor, with a minimum of 6" of RMC embedded in concrete.
9. Cut raceways square using saw or pipe cutter.
10. Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 2", unless sweep elbows required. Bend raceways according to manufacturer's recommendations. Factory fittings are only permitted for PVC and RMC only.
11. Use raceway fittings compatible with raceways and suitable for use and environment.

12. Provide bushings on all raceways.
13. Raceways minimum sizes:
 - a. Minimum raceway size 3/4", except as noted on drawings.
 - b. Minimum home run size: 3/4", except as noted on drawings.
 - c. Minimum size for flexible metal conduit is 1/2".
 - d. Minimum size for liquid tight flexible metal conduit is 1/2"
14. Install empty raceways 2-1/2" and larger with 2500# pull tape; install 200 lb nylon pull cord in raceways smaller than 2-1/2"; leave at least 12" of slack at each end of pull wire. Cap raceways at both ends.
15. Feed devices on same wall vertically from above or junction box in suspended ceiling.
 - a. Do not install horizontal bends in conduit around corners.
 - b. Feed devices in exterior or load-bearing walls by horizontal conduit runs.
16. Raceways Supports:
 - a. Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
 - b. Raceway supports for horizontal or vertical single runs:
 - 1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
 - 2) Spring steel type pressure clamps for raceways 3/4" and smaller.
 - c. Raceway supports for horizontal and vertical multiple runs:
 - 1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
 - 2) Support horizontal runs with appropriately sized rods.
 - 3) Anchor vertical runs to structure.
 - 4) Spring-steel type pressure clamps for raceways 3/4" and smaller.
 - d. Vertical raceway runs 1-1/4" and larger passing through floors: Support at each floor with pipe riser clamps.
 - e. Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.
 - f. Secure raceways in metal stud walls to prevent rattling.
 - g. Arrange raceway supports to prevent misalignment during wiring installation.
 - h. Do not fasten raceways to corrugated metal roof deck.
 - i. For fasteners and supports, including steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 26 05 29 - Hangers and Supports for Electrical Systems and NFPA 70.
17. Raceways Seismic Restraints:

- a. Avoid raceway runs crossing building seismic joints. Use flexible connections where crossings cannot be avoided.
- b. Install rigid bracing and lateral restraints for suspended raceway runs per requirements in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
18. Identify raceways per requirements in Section 26 05 53 - Electrical Systems Identification.
19. Ground raceways per requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.
20. Flexible Conduit Connections: Use maximum of 72" of flexible conduit for recessed and semi- recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for motors.
 - a. Use LFMC in damp or wet locations
21. Install PVC-coated raceways in areas with corrosive atmosphere as noted on plans.
22. Use tools approved for use with PVC coated conduits and fittings.
23. Install stainless steel raceway clamps, mounting hardware, supports, hangers, etc., when located in "wet" or "wash-down" areas.
24. Communications Raceways:
 - a. Minimum communications raceway size: 1", unless otherwise noted on drawings.
 - b. Install one raceway from each communications outlet box. Horizontal raceway runs between wall outlet boxes are not allowed.
 - c. Install insulated bushings on end of each raceway.
 - d. Use UL listed metallic grounding clamps, when terminating raceway on cable tray.
 - e. Install flush two-gang box with two-gang trim ring for each communications outlet or as noted on drawings.
 - f. Install with no more than 180-degrees of bends between pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
 - g. Conduit bend radii (minimum) shall be:
 - 1) Six (6) times internal conduit diameter for conduit 2" or less internal diameter.
 - 2) Ten (10) times internal conduit diameter for conduit greater than 2" internal diameter.
 - h. Conduit bends shall be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.
 - i. Do not install 90-degree condulets. Install continuous radius sweeps of 45-degree minimum for 90-degree bends.
 - j. Do not install continuous sections longer than 100 ft.

- k. Install nylon pull cord in empty raceways. Leave at least 12" of slack at each end of pull wire. Cap raceways at both ends.
25. Power and low-voltage raceways: Minimum 12" separation when run parallel, cross perpendicular.
- B. Boxes:
- 1. Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.
 - 2. Install the appropriate cover on surface-mounted boxes:
 - a. Raised device covers on 4" square and 4-11/16" boxes and handy box covers on handy boxes, etc.
 - b. Device covers that are square drawn or square cut on boxes in block.
 - c. Tile covers on boxes in tile.
 - d. Round drawn device covers on boxes in lath and plaster walls or dry wall only.
 - e. Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
 - 3. Set outlet boxes parallel to construction and independently attached to same.
 - 4. Do not install back-to-back and through-the-wall boxes. Install with minimum 6" horizontal separation between closest edges of the boxes. Install with minimum 24" separation in acoustic-rated walls and fire-rated walls.
 - 5. Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.
 - 6. Box Support:
 - a. Mount boxes straight.
 - b. Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.
 - c. Install stud support one side, with short piece of stud, for up to 2 gang device boxes.
 - d. Do not support boxes with tie-wire.
 - e. For one and two gang box support, manufactured bracket supports shall be accepted alternate.
 - f. Support boxes independently of raceways.
 - g. Install adjustable steel channel fasteners for hung ceiling outlet box.
 - h. Install stamped steel bridges to fasten flush-mounted outlet box between studs.
 - i. Do not install boxes to ceiling support wires or piping systems.
 - 7. Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.

8. Mount boxes in block walls at block joint nearest to indicated height.
 9. 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.
 10. When boxes are installed in fire-resistive walls and partitions, provide 24" horizontal separation between boxes on opposite sides of a wall. In addition, limit penetrations to 16 sq in per penetration and not to exceed a total of 100 sq in per 100 sq ft of wall area. Apply fire stop putty pads acceptable to the fire marshal.
 11. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.
 12. Install boxes to be permanently accessible.
 13. Do not intermix conductors from more than one system in same junction box or pull box, unless shown or specifically authorized otherwise.
 14. Adjust box location up to 10' prior to rough-in to accommodate intended purpose.
 15. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26 - Wiring Devices.
 16. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6" from ceiling access panel or from removable recessed luminaire.
 17. The drawings do not necessarily show every outlet, pull or junction box required. Add all required boxes as necessary.
- C. Floor Boxes:
1. Set metal floor boxes level and flush with finished floor surface.
 2. Use cast floor boxes for installations in slab on grade.
 3. Install floor boxes and fittings to preserve fire-resistant rating of slabs and other elements, using materials and methods specified in Section 26 05 93 - Electrical Systems Firestopping.
 4. Power and IT or AV conduits require a minimum 12" separation where routed parallel including entry into floor boxes.
- D. Expansion Fittings:
1. Install raceway expansion and deflection fittings in all raceway runs embedded in or penetrating concrete where movement perpendicular to axis of the raceway may be encountered.
 2. Install raceway expansion fittings complete with bonding jumpers in raceway runs that cross- expansion joints in structure and raceway runs mechanically attached to 2 separate structures.
 3. Use couplings and flexible connection made up of 24" length of flexible metal conduit, where EMT runs across expansion joints in ceiling spaces.

4. Install fitting(s) that provide expansion and contraction for at least 0.0004" per ft of length of straight run per °F of temperature change.
 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.
- E. Raceway Penetration Seals:
1. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
 2. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Maintenance of Joint Protection" for materials and installation.
 3. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Section 26 05 93 - Electrical Systems Firestopping.
 4. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
 5. Conduits may be directly cast into above grade concrete walls and slabs.
 6. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annual clear space between pipe and sleeve for installing mechanical sleeve seals.
 7. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1" annual clear space between raceway and sleeve for installing mechanical sleeve seals.
 8. Sleeve-Seal Installation: Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 9. Provide chrome- or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.
 10. Remove temporary sleeves, if used for form wall openings, prior to installation of permanent materials.
- F. Raceway Sealing Fittings:
1. Install listed watertight seals to prevent the passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of the building,

where raceway passes between areas of different temperatures such as into or out of cold rooms or freezers, where raceway enters room which at any time is subject to low or high temperatures and where raceway enters a room which at any time is subject to internal air pressures above or below normal.

2. Install watertight seals in interior of all raceways passing through building roof, ground floor slab (when the raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on the end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank cover plate to match finish of adjacent plates or surfaces.
3. Seal raceways entering or passing through "hazardous (classified) areas" as defined in NFPA 70.

G. Sleeve Installation for Electrical Penetrations:

1. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 05 93 - Electrical Systems Firestopping.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Rectangular Sleeve Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50" and no side greater than 16", thickness shall be 0.052".
 - b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50" and 1 or more sides equal to, or greater than, 16", thickness shall be 0.138".
4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies, unless openings compatible with firestop system used are fabricated during construction of floor or wall.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors 2" above finished floor level.
7. Size pipe sleeves to provide 1/2" annular clear space between sleeve and raceway, unless sleeve seal is to be installed or unless seismic criteria require different clearance.

3.4 APPLICATION

- A. Raceway uses permitted and not permitted per NFPA 70 requirements, Cal Poly Standards, and as described below. Raceways and cables not listed in this section are not permitted for use on campus.
- B. RNC Raceways:
 1. Above and below grade concrete encasements.
 2. Below grade native or sand encasements.
 3. In exposed corrosive areas (Schedule 80) with approval from the owner.

4. Not exposed or concealed above grade.
- C. Rigid Metal Conduit (RMC) permitted to be installed as follows:
1. Installations below grade and in or under concrete slabs with corrosion protection tape
 2. All transitions for below grade to above grade with 6" minimum embedment.
 3. Pump HVAC and building equipment rooms.
 4. Concealed in concrete or block encasements
 5. Above grade in exposed locations
 6. All locations except corrosive atmospheres
 7. Hazardous locations
 8. Locations requiring mechanical protection
- D. Aluminum RMC
1. Food service areas.
 2. Other areas approved or indicated on the drawings.
- E. Electrical Metallic Tubing (EMT) permitted to be installed as follows:
1. Interior partitions
 2. Above suspended ceilings
 3. Exposed in telecom and electric rooms.
 4. In labs and warehouses where installed above 10' AFF.
 5. Not used in outdoor, wet or damp locations.
- F. Flexible Metal Conduit (FMC) permitted to be installed as follows:
1. Areas where a building finish will conceal this installation (wall, ceiling tile). Not exposed when building finishes are complete.
 2. In lengths not to exceed 20' between accessible junction or pull boxes.
 3. No flexible metal conduit length restriction when using "Manufactured Wiring Systems."
- G. Liquid Tight Flexible Metal Conduit (LFMC) permitted to be installed as follows:
1. Areas where will not be concealed by a building finish.
 2. Concrete encasements.
 3. Use liquid tight flexible conduit, 2 ft to 4 ft in length, for final connections to:
 - a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment) in wet locations.
 - b. Instruments and control devices
 - c. Kitchen equipment
- H. Stainless Steel Conduit
1. Use exposed stainless-steel conduit as directed on drawings.

- I. One-half inch raceway permitted:
 1. Between controller and its control or pilot device
 2. Between lighting switch and nearest outlet for luminaire
 3. Control wiring where mounted on equipment where conduit must follow contour of equipment
 4. Protective and signal systems where noted.
 5. Where shown on plans

3.5 RACEWAY WIRING METHODS

- A. Underground:
 1. Install rigid steel conduit or RNC with appropriate corrosion protection.
 2. RNC - Schedule 40 PVC
 3. Install concrete or polycast boxes of appropriate size.
- B. In or Under Slab on Grade:
 1. Install rigid steel conduit RMC with appropriate corrosion protection.
 2. Install RNC and transition to RMC with 6" of embedment for above slab.
 3. Cast metal floor boxes, plastic floor boxes with metal finish hardware to finish floor.
- C. Outdoor Locations, Above Grade:
 1. Install rigid steel conduit RMC
 2. Install LFMC as required for equipment connections.
 3. Install cast metal or nonmetallic outlet, pull, and junction boxes. Install flush mounting outlet boxes in finished areas.
- D. Wet and Damp Locations:
 1. Install rigid steel conduit RMC
 2. Install cast metal or nonmetallic outlet, junction, and pull boxes. Install flush mounting outlet boxes in finished areas.
 3. Install LEMC as required for equipment connections
- E. Concealed Dry Locations:
 1. Install electrical metallic tubing; install sheet metal boxes; install flush mounting outlet boxes in finished areas; install hinged enclosure for large pull boxes (above 24X24).
 2. Install FMC where lengths between accessible pulling points does not exceed 20 feet.
- F. Exposed Dry Locations (Classrooms, Laboratories, Offices, Hallways, Kitchens, Dorm Rooms, Restrooms, Gyms, Stairwell, Utility Rooms, etc.):
 1. Make every effort to conceal electrical infrastructure.

2. Use "Surface Raceway" 26 05 33.13 for areas where concealment is not possible.
 3. LFMC for equipment connections that are hardwired.
- G. Exposed Dry Locations (Workshops, Warehouses, Store Rooms, etc.):
1. EMT at location 10" AFF.
 2. RMC at locations below 10' AFF.
 3. LFMC for equipment connections that are hardwired.
- H. Mechanical/ Electrical Rooms:
1. RMC for mechanical rooms that have water piping in the same space.
 2. EMT for electrical rooms or mechanical rooms with no water piping.
 3. LFMC for equipment connections that are hardwired.
- I. Corrosive Environments:
1. Refer to University for direction.
- J. Foodservice Areas:
1. Refer to University for direction.
- K. Exposed Subject to Damage:
1. Install rigid steel conduit.
- L. Hazardous Locations:
1. Install rigid steel conduit; install cast metal boxes.

3.6 FIELD QUALITY CONTROL

- A. Inspect raceway, boxes, indoor service poles, and wireways for physical damage, proper alignment, supports and seismic restraints, where applicable.
- B. Replace any damaged component of the raceway system, or install new raceway system.
- C. Inspect components, wiring, connections and grounding.

3.7 REPAINTING

- A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner's Representative.
- B. Repair damage to PVC or paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner's Representative.

- C. Wireways, indoor service poles: Remove paint splatters and other marks from surface; touch-up chips, scratches, or marred finished to match original finish using manufacturer-supplied paint kit. Leave remaining paint with Owner's Representative.

3.8 ADJUSTING

- A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.
- B. Install knockout closures in unused openings in boxes.
- C. Align adjacent wall-mounted outlet boxes for switches and similar devices.
- D. Adjust outlet boxes to allow luminaires to be positioned as indicated on reflected ceiling plan.

3.9 CLEANING

- A. Clean interior and exterior of boxes, wireways, and indoor poles to remove dust, debris and other material.

END OF SECTION 26 05 33

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- C. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
- D. Section 26 22 00 - Low-Voltage Transformers
- E. Section 26 23 00 - Low-Voltage Switchgear
- F. Section 26 24 13 - Switchboards
- G. Section 26 24 16.13 - Lighting and Appliance Panelboards
- H. Section 26 24 16.16 - Distribution Panelboards
- I. Section 26 28 16 - Enclosed Switches and Circuit Breakers
- J. Section 26 29 13 - Enclosed Controllers
- K. Section 26 32 13 - Engine Generators
- L. Section 26 36 23 - Automatic Transfer Switches
- M. Section 26 51 00 - Interior Lighting

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes requirements for seismic restraints, vibration control and anchorage to building structure of electrical systems, including equipment specified in paragraph "Related Work", raceways, cable trays, and lighting fixtures:

1. Seismic restraints, vibration control and anchorage to building structure shall meet ratings applicable to seismic Design Category.
- B. Obtain services of Engineer registered and licensed in the State of California to design seismic restraints, vibration control and methods of anchorage of electrical systems to building structure.
- C. Seismic anchorage and restraints shall be designed and installed in accordance with codes and standards as enforced by Authorities Having Jurisdiction in the State of California. Authorities shall include Owner's insurance company.

1.4 REFERENCE STANDARDS

- A. ASTM A 492 - Specification for Stainless Steel Rope Wire
- B. ASTM A 603 - Specification for Zinc-Coated Steel Structural Wire Rope
- C. ASTM E 488 - Specification for Test Methods for Strength of Anchors in Concrete and Masonry Elements
- D. AWS D1.1/D1.1M - Structural Welding Code - Steel
- E. IBC - International Building Code
- F. ICC-ES - International Code Council Evaluation Service
- G. MFMA-3 - Metal Framing Standards Publication
- H. NFPA 70 - National Electrical Code
- I. NFPA 5000 - Building Construction and Safety Code
- J. SEI/ASCE 7-05 - Structural Engineering Institute/American Society of Civil Engineers - Minimum Design Loads for Buildings and Other Structures

1.5 PERFORMANCE REQUIREMENTS

- A. Governing Codes:
 1. 2006 IBC, Section 1613, which references and modifies SEI/ASCE 7-05, Chapter 13
 2. Currently adopted version of the California Building Code (CBC)
- B. In Sections for equipment and components in structures with an Importance Factor greater than in IBC Seismic Design Category C, D, E, or F, a "Manufacturer Seismic Qualification Certification" is required in Part 1 "Submittals" Article that certifies that

equipment will withstand seismic forces derived from criteria specified in this Section, and that equipment will remain internally intact to be operable with little or no delay.

- C. In Sections for equipment and components other than those noted above, a "Manufacturer Seismic Qualification Certification" is required in Part 1 "Submittals" Article that certifies that equipment will remain physically intact when subjected to seismic forces derived from criteria specified in this Section.
- D. Seismic-Restraint Loading:
 - 1. Building Seismic Design Category as defined in the UBC: A
 - 2. Site Class as Defined in the IBC: A
 - 3. Assigned Occupancy Category as Defined in the IBC: III
 - 4. Component Importance Factor: 1.0
 - a. Non-hazardous and non-life safety systems shall have component importance factor (Ip) of 1.0.
 - b. Life safety systems shall have component importance factor (Ip) of 1.5, and following system shall be classified as life safety systems:
 - 1) Emergency systems per NEC Article 700.
 - 2) Life safety branch of emergency systems per NEC Article 517.
 - 5. Component Response Modification Factor: 1.5
 - 6. Component Amplification Factor: 1.0
- E. Lateral bracing forces shall be determined using equations listed in SEI/ASCE, Chapter 13.

1.6 SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 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 agency acceptable to Authorities Having Jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
 - 1. Submit vibration isolation and seismic-restraint details:
 - a. Indicate fabrication and arrangement.

- b. Detail attachments of restraints to the restrained items and to the structure.
 - c. Show attachment locations, methods, and spacings.
 - d. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - e. Indicate association with vibration isolation devices.
2. Submit design calculations. Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints:
 3. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 4. Submit design analysis to support selection and arrangement of vibration isolation and seismic restraints. Include calculations of combined tensile and shear loads.
 5. Submit welding certificate.
 6. Submit field quality control test reports.
 7. Shop drawings, including calculations, shall be signed and sealed by a Structural Engineer registered and licensed in the State of California.
- C. Submit manufacturer Seismic Qualification Certification of Compliance for review by Authority Having Jurisdiction, per SEI/ASCE.
- D. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

1.7 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to Authorities Having Jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred.
- D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control
 - 6. Mason Industries
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation
 - 9. Vibration Mountings & Controls, Inc.

- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment:
 - 1. Resilient Material: Oil- and water-resistant [neoprene] [rubber] [hermetically sealed compressed fiberglass].

- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50% of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80% of rated vertical stiffness.
 - 4. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4" thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4" thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Seismic or limit-stop as required for equipment and Authorities Having Jurisdiction.

3. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50% of the required deflection at rated load.
5. Lateral Stiffness: More than 80% of rated vertical stiffness.
6. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers:
 1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation
 3. Cooper B-Line, Inc.; a division of Cooper Industries
 4. Hilti Inc.
 5. Loos & Co.; Seismic Earthquake Division
 6. Mason Industries
 7. TOLCO Incorporated; a brand of NIBCO INC.
 8. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements 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 4 times the maximum seismic forces to which they will be subjected.
- C. 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.
- D. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors 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.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor: 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 E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. Hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-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 after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- 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: Install hanger rod stiffeners 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.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125".
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to Authorities Having Jurisdiction providing required submittals for component.
- B. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- C. 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.
- D. Restraint cables: Provide slack with maximums recommended by manufacturer.
- E. 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.
- F. 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.

3.4 METHODS AND MATERIALS

- A. Vibration control and seismic restraint methods and materials shall be supplementary to supporting devices and together shall serve as equipment support criteria. Provide hangers and supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- 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 they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections.
- C. 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 Owner's Representative, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least 7 days advance notice.
 3. Obtain Owner's Representative' approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least 4 of each type and size of installed anchors and fasteners selected by Owner's Representative.

5. Test to 90% of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust isolators after isolated equipment 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 active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48

SECTION 26 05 53 - ELECTRICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 13.16 - Medium-Voltage Cable
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- C. Section 26 05 33 - Raceways and Boxes for Electrical Systems
- D. Section 26 05 43 - Underground Ducts and Raceways for Electrical Systems
- E. Section 26 05 73 - Power System Studies
- F. Section 26 09 23 - Lighting Control Devices
- G. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
- H. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
- I. Section 26 22 00 - Low-Voltage Transformers
- J. Section 26 23 00 - Low-Voltage Switchgear
- K. Section 26 24 13 - Switchboards
- L. Section 26 24 16.13 - Lighting and Appliance Panelboards
- M. Section 26 24 16.16 - Distribution Panelboards
- N. Section 26 27 13 - Electrical Metering
- O. Section 26 27 26 - Wiring Devices
- P. Section 26 28 16 - Enclosed Switches and Circuit Breakers
- Q. Section 26 29 13 - Enclosed Controllers
- R. Section 26 32 13 - Engine Generators
- S. Section 26 36 23 - Automatic Transfer Switches

- T. Section 26 43 00 - Surge Protection Devices
- U. Section 28 31 16 - Multiplexed Fire Detection and Alarm Systems

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

- A. Section includes the following:
 1. Identification for raceway and metal-clad cable
 2. Identification for conductors and communication and control cable
 3. Underground-line warning tape
 4. Warning labels and signs
 5. Instruction signs and posted drawings
 6. Equipment identification nameplates
 7. Wiring devices identification
 8. Miscellaneous identification products
- B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.4 REFERENCE STANDARDS

- A. ANSI A13.1 - Scheme for the Identification of Piping Systems
- B. ANSI C2 - National Electrical Safety Code
- C. ANSI Z535.4 - National Standards for Product Safety Signs and Labels
- D. 29 CFR - Labor, Part 1910 - Occupational Safety and Health Standards, Section 19 10 .145 - Specifications for Accident Prevention Signs and Tags
- E. NFPA 70 - National Electrical Code

1.5 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Architect for approval indicating nameplate size, lettering size, color and actual nameplate information.

- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- D. See subsection "University Standards" below.

1.6 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.7 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.8 UNIVERSITY STANDARDS

- A. Submittals:
 - 1. Provide a sample of all label type for the particular project to the University for approval prior to the execution of any label or identification placement.
 - 2. Identification of power receptacles, equipment disconnects and other utilization devices and equipment.
 - 3. Provide a thermoplastic engraved legend, white background with black letters that denotes the panel designation and circuit designation per below example:
 - a. 1LA 2,4,6
 - b. Where "1LA" is the panel designation and "2,4,6" is the circuit designation.
 - 4. Minimum size for power receptacles is .5" high by 1.5" wide with .25" letters.
 - 5. Affix to the device using 30 year silicone adhesive.
- B. Labels for Panel boards, Distribution Boards and Switchgear
 - 1. Panel boards are to be named using the following scheme: #XY

- a. Where # denotes the floor number where the equipment is located Where X denotes the voltage:
 - b. L = 208/120V 3 Phase or 240/120V 1 Phase M = 240V 3 Phase
 - c. H = 480/277V 3 Phase or 480V
 - d. Where Y denotes the panel designation on that floor. A, B, C and so forth
 2. Sub panels will be labeled as follows: #XY-\$
 - a. Where \$ is the number 1, 2, 3 etc. of the sub panel feed from the panel board
 3. Distribution boards will be named using the following scheme: #DBXY Where # denotes the floor number where the equipment is located Where X denotes the voltage:
 - a. L = 208/120V 3 Phase or 240/120V 1 Phase M = 240V 3 Phase
 - b. H = 480/277V 3 Phase or 480V
 - c. Where Y denotes the Distribution Board designation on that floor. A, B, C and so forth
 4. Main Switchgear will be named as follows: #-MDB-\$
 - a. Where # is the building number and \$ is the switchgear number if there is more than one. See University Representative if further clarification is needed. Use 30 year silicon adhesive to attach legend to panel enclosure.
- C. Labels for Medium Voltage Conductors and Equipment
1. Provide a waterproof tag (laminated plastic or similar) on each end of termination and in each manhole or pull box indicating the Feeder # from the drawings, the from location, the to location and the approximate feet at the location of the label. Color scheme is as follows:
 - a. Normal circuits: black nameplate with white letters
 - b. Emergency circuits: red nameplate with white letters
 - c. Standby circuits: yellow nameplate with black letters
 - d. Fire alarm circuits: red nameplate with yellow letters
 - e. Communication circuits: orange nameplate with white letters
 2. Provide thermoplastic engraved legends with white letters on a black background indicating the asset identification number as shown on the drawings. Labels are to be a minimum of 1" high by 3" long with .5" letters. Use 30 year silicon adhesive to attach legend to the enclosure.
- D. Labels for Junction and Pull Boxes
1. Exposed locations: Provide a thermoplastic engraved legend with white letters on a black background indicating the contents, panel numbers and circuit numbers of conductors and equipment in the box. Use 30 year silicon adhesive to attach legend to the box.

2. Concealed locations: Write legibly from a distance of 15 feet on the box with an indelible ink marker as the contents, panel numbers and circuit numbers of the conductors and equipment in the box.
- E. Circuit Directories
1. Circuit Directories are to be installed in a permanent enclosure on the inside of the door of the equipment that they are in reference to.
 2. Circuit Directories are to be neatly typed and include the panel designation, date and the source of electricity for the panel.
 3. Circuit directories are to provide enough description of each load or circuit such that an operator can distinguish a particular load in questions from all other loads in the panel without the use of a circuit tracer or similar tools. Provide a map or diagram with directory if appropriate.
- F. Wire Identification
1. All wires are to be installed in their corresponding phase colors. See above in section 26 05 00.
 2. Panel connections will have circuit number tape on the ungrounded phase conductors to indicate their specific circuit number.
 3. Panel connections will have circuit number tape on the grounded conductors (neutrals) to indicate their specific circuit numbers.
- G. Other Electrical Identification
1. All VFD, Lighting Controllers, Relay Cabinets and thermoplastic engraved legend with white letters on black background indicating the equipment designation. Use 30 year silicon adhesive to attach legend.
 2. All power outlets, power disconnects and lighting switches will have an engraved plastic legend indicating their feed panel and circuit number. Glue engraved legend in place with silicone.

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MSI), Seton, or approved equal.
- C. Color for Printed Legend:
1. Power Circuits: Black letters on an orange field.
 2. Legend: Indicate system or service and voltage, if applicable.

- D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical- resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.
- F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2" long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend.
- B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or equal.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Aluminum Wraparound Marker Labels: Cut from 0.014" thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- E. Metal Tags: Brass or aluminum, 2" x 2" x 0.05", with stamped legend, punched for use with self- locking nylon tie fastener.
- F. Write-On Tags: Polyester tag, 0.015" thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- G. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Manufacturers: Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.
- B. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6" wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip.
4. Printed legend shall indicate type of underground line.
5. Red tape for electrical and orange tape for communications installations.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Self-Adhesive Arc Flash Warning Labels: Industrial grade, made of durable polyester with over-laminate to withstand harsh environments (UV rays, scratches and most chemicals).
 1. Manufacturer: Seton or approved equal
- D. Engraved Plastic Signs: Engraving stock, melamine plastic laminate, minimum 1/16" thick for signs up to 20 sq in and 1/8" thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. No punched or drilled mechanical fasteners are permitted
 3. Color schemes is as follows:
 - a. Normal: black background with white letters
 - b. Emergency: red background with white letters
 - c. Standby: yellow background with black letters
 - d. Fire alarm: red background with yellow letters
 - e. Communication: orange background with white letters
- E. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4" grommets in corners for mounting. Nominal size, 7" x 10".
- F. Metal-Backed, Butyrate Warning Signs for Exterior Use: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396" galvanized-steel backing; and with colors, legend, and size required for application. 1/4" grommets in corners for mounting. Nominal size, 10" x 14".
- G. Warning label and sign shall 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 36 INCHES."

3. Arc Flash Labels: Per ANSI Z535.4, the signal word WARNING appearing in black letters on an orange background, with second line below (Arc Flash and Shock Hazard) in black letters on white background and third line below (Appropriate PPE Required) in black letters on white background. Include the following information on the label:
 - a. Equipment name
 - b. Available bolted current
 - c. Flash protection boundary distance 2
 - d. Incident energy level at 18" expressed in cal/cm
 - e. Personnel protective equipment (PPE) class
 - f. Voltage shock hazard
 - g. Limited shock approach boundary
 - h. Restricted shock approach boundary
 - i. Prohibited shock approach boundary

2.5 INSTRUCTION SIGNS AND POSTED DRAWINGS

- A. Instruction Signs: Engraved, laminated acrylic or melamine plastic, minimum 1/16" thick for signs up to 20 sq in and 1/8" thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Mounting Frames: Extruded aluminum, 4-point screw mount with 1/8" clear plexiglass cover.
- B. Posted Drawings: Print electrical riser diagrams on 20 lb bond paper. (Blueprint paper is not acceptable.) Reduce drawings to approximately 1/2 size using Xerox reduction process. Contact Engineer to obtain updated original plans for printing.

2.6 EQUIPMENT IDENTIFICATION NAMEPLATES

- A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Punched or drilled for screw mounting. Minimum letter height shall be 3/8" unless noted otherwise.
- B. Color schemes to be as follows:
 1. Typical u.n.o. below: black background with white letters
 2. Emergency: red background with white letters
 3. Standby: yellow background with black letters
 4. Fire alarm: red background with yellow letters
 5. Communication: orange background with white letters

2.7 WIRING DEVICES IDENTIFICATION

- A. Refer to Section 26 27 26 - Wiring Devices for requirements.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16"
 - 2. Tensile Strength: 50 lb minimum
 - 3. Temperature Range: -40°F to 185°F
 - 4. Color: Black, except where used for color-coding
- B. Paint: Paint materials and application requirements are specified in Division 09 - Finishes painting Sections.
- C. 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

3.1 APPLICATION

- A. Raceway and Ductbanks More Than 600 V Concealed within Buildings: 4" wide black stripes on 10" centers over orange background that extends full length of raceway or duct and is 12" wide. Stencil legend "DANGER CONCEALED HIGH-VOLTAGE WIRING" with 3" high black letters on 20" centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12" of a 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 the building, or concealed above suspended ceilings.
- B. Accessible Raceways More Than 600 V: Identify raceways by painting with red paint the entire length of raceways. Stencil the legend "DANGER - HIGH VOLTAGE [XXX] VOLTS" in black letters at least 2" high. Repeat legend at 10 ft maximum intervals.
 - 1. Identify covers of exposed junction and pull boxes with red paint. Stencil the legend "DANGER - HIGH VOLTAGE [XXX] VOLTS" in black letters 1/2" high.
- C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A: Identify with orange [self-adhesive vinyl labels].
 - 1. Identify 4" round, 4" square and 4-11/16" junction boxes concealed above ceiling or exposed with neat lettering on cover with permanent black marking pen. Identify source, circuit number, phase, and control circuit number.

- D. Accessible Raceways and Cables of Auxiliary Electrical Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands, and as required per code:
1. Fire Alarm System (including covers of pull and junction boxes): Red
 2. Fire-Suppression Supervisory and Control System: Red and yellow
 3. Combined Fire Alarm and Security System: Red and blue
 4. Security System: Blue and yellow
 5. Mechanical and Electrical Supervisory System: Green and blue
 6. Telecommunication System: Green and yellow
- E. Conductors to Be Extended in the Future and Spare Conductors: Attach write-on tags to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with project drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.
1. 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
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
 3. Arc Flash Warning Labels: install per NFPA 70 for each switchgear, switchboard, panelboard, motor control center, industrial control panel (every enclosure that may contain energized conductors or components). Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.

4. Available Fault Current Labels: install per NFPA 70 for each piece of service entrance equipment. Locate labels so they are visible to the personnel before examination, adjustment, servicing or maintenance of the equipment.
- I. Instruction Signs and Posted Drawings:
 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend printed in all capital letters of 12 pt size minimum where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8" high letters for emergency instructions at equipment used for power transfer.
- J. Emergency Electrical System Junction and Pull Boxes:
 1. Identify with spray-painted covers as follows:
 - a. 480/277 V circuits: Red/Brown
 - b. 120/208 V circuits: Red/White
 2. Confirm with University for boxes located in concealed areas.
- K. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 1. Nameplate Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated, provide a single line of text with 1/2" high letters (1/4" where space is limited) on 1-1/2" high nameplate; where 2 lines of text are required, use nameplates sized 2" high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine nameplates sized similar to indoor equipment nameplates
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 2. Install nameplates for equipment including, but not limited to, the following:
 - a. Panelboards, electrical cabinets, and enclosures
 - b. Access doors and panels for concealed electrical items
 - c. Electrical switchgear, switchboards, and distribution panelboards including each feeder device within the equipment enclosures.
 - d. Transformers
 - e. Electrical substations

- f. Emergency system boxes and enclosures
 - g. Motor-control centers, including each device
 - h. Disconnect switches
 - i. Enclosed circuit breakers
 - j. Motor controllers
 - k. Pushbutton stations
 - l. Power transfer equipment
 - m. Contactors
 - n. Remote-controlled switches, dimmer modules, and control devices
 - o. Battery inverter units
 - p. Battery racks
 - q. Power-generating units
 - r. Voice and data cable terminal equipment
 - s. Master clock and program equipment
 - t. Intercommunication and call system master and staff stations
 - u. Television/audio components, racks, and controls
 - v. Fire alarm control panel and annunciators
 - w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks
 - x. Monitoring and control equipment
 - y. Uninterruptible power supply equipment
 - z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions
 - aa. Non-concealed junction box covers of auxiliary electrical systems
3. Provide the following information on each nameplate:
- a. Equipment name/tag:
 - 1) Matching the designation from the contract documents, or identifying the load controlled or function of the equipment where no specific tag is shown on the contract documents.
 - 2) For disconnect switches, use the prefix "SW-" followed by the name of the equipment served, example: "SW-PMP-201."
 - b. Equipment operating voltage, phase, wiring configuration, and ampacity: 1)
Example: "208V/3PH/4W/225A"
 - c. Source of power supply, including circuit number:
 - 1) Example: "FED FROM LP-2/45"
- L. For service entrance equipment, provide a nameplate identifying the maximum available fault current and "as of" effective date.
- 1. Example: "MAXIMUM AVAILABLE FAULT CURRENT 33,500A AS OF 2017/06/15."
- M. Access Panel Identification: Furnish typewritten charts with identification and location of access panels serving equipment and incorporate in O&M Manuals.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach with screws and auxiliary hardware appropriate to the location and substrate. Secure to inside surface of door or panelboard that is recessed in finished locations.
- F. Posted Drawings and Operating Instructions: Mount drawings and operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment.
- G. Warning Signs: Install warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.
 - 1. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed to convey the message; example: "DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED."
- H. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
- I. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Colors for 208/120 V Circuits:
 - a. Phase A (left bus in panelboard): Black
 - b. Phase B (center bus in panelboard): Red
 - c. Phase C (right bus in panelboard): Blue
 - d. Neutral: White

- 1) Dedicated neutral, Phase A: white with black tracer
 - 2) Dedicated neutral, Phase B: white with red tracer
 - 3) Dedicated neutral, Phase C: white with blue tracer
 - e. Equipment Ground: Green
 2. Colors for a 240V 3 Phase System:
 - a. Phase A: Black
 - b. Phase B: Purple
 - c. Phase C: Blue
 3. Colors for a 240/120V Single Phase Systems:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Neutral: White
 4. Colors for 480/277 V Circuits:
 - a. Phase A (left bus in panelboard): Brown
 - b. Phase B (center bus in panelboard): Orange
 - c. Phase C (right bus in panelboard): Yellow
 - d. Neutral: Gray
 - 1) Dedicated neutral, Phase A; gray with brown tracer
 - 2) Dedicated neutral, Phase B: gray with orange tracer
 - 3) Dedicated neutral, Phase C: gray with yellow tracer
 - e. Equipment Ground: Green
 5. Where dedicated neutrals are required or are shown on the drawings, neutral insulation color shall be either white or gray with colored tracer to match color of phase conductor to which neutral is dedicated.
 6. All conductors will be manufactured in their corresponding phase color identifiers. The use of phase tape or other means in not acceptable.
- J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6" to 8" below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16" overall.
- K. Painted Identification: Prepare surface and apply paint according to Division 09 - Finishes painting Sections.

END OF SECTION 26 05 53

SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 53 - Electrical Systems Identification
- B. Section 26 08 12 - Power Distribution Acceptance Tests
- C. Section 26 08 13 - Power Distribution Acceptance Test Tables
- D. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
- E. Section 26 22 00 - Low-Voltage Transformers
- F. Section 26 23 00 - Low-Voltage Switchgear
- G. Section 26 24 13 - Switchboards
- H. Section 26 24 16.13 - Lighting and Appliance Panelboards
- I. Section 26 24 16.16 - Distribution Panelboards
- J. Section 26 28 13 - Fuses
- K. Section 26 28 16 - Enclosed Switches and Circuit Breakers
- L. Section 26 29 13 - Enclosed Controllers
- M. Section 26 36 23 - Automatic Transfer Switches

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes computer based, fault current, arc flash, and overcurrent protective device coordination studies for an electrical distribution system, based on actual equipment supplied. Set protective devices based on results of the protective device coordination study.

1. Coordination of series-rated devices is not permitted.
- B. Furnish field information and data needed for the studies.
- C. Available fault current and electrical equipment interrupting capacity indicated on drawings are based on the short circuit study performed during design as part of the construction documents.
- D. Provide studies and reports prior to manufacture of the electrical distribution equipment.
- E. Equipment submittal will not be approved until the coordination study is complete and the equipment submittals indicate compliance with the study recommendations.

1.4 REFERENCE STANDARDS

- A. ANSI C57.12.10 - American National Standard for Transformers-230 kV and Below 833/958- 8333/10 417 kVA, Single-Phase, and 750/862-60 000/80 000/100 000 kVA, Three-Phase, w/o Load Tap Changing; and 3750/4687-60 000/80 000 kVA with Load Tap Changing-Safety Requirements
- B. ANSI C57.12.22 - American National Standard for Transformers-Pad-Mounted, Compartmental- Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA & Smaller: High-Voltage, 34 500 GrdY/19 920 V & Below; Low Voltage, 480 V & Below- Requirements
- C. ANSI C57.12.40 - American National Standard for Secondary Network Transformers-Subway and Vault Types (Liquid Immersed)-Requirements
- D. ANSI C57.12.90 - General Requirements for Liquid-Immersed Distribution Power and Regulating Transformers
- E. ANSI C57.96 - Distribution and Power Transformers, Guide for Loading Dry-Type (Appendix to ANSI C57.12 Standards)
- F. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants
- G. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings
- H. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- I. IEEE 399 - Recommended Practice for Power System Analysis

- J. IEEE 620 - Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines
- K. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
- L. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations
- M. IEEE C37.010 - Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
- N. IEEE C37.20.1 - IEEE Standard for Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear
- O. IEEE 37.46 - American National Standard Specifications for Power Fuses and Fuse-Disconnecting Switches
- P. IEEE C57.12 - General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
- Q. IEEE C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers
- R. ICEA P-32-382 - Short-Circuit Characteristics of Insulated Cable
- S. ICEA P-45-482 - Short-Circuit Performance of Metallic Shielding and Sheaths of Insulated Cable
- T. NEMA MG 1 - Motors and Generators
- U. NFPA 70 - National Electrical Code (NEC)
- V. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance
- W. NFPA 70C - Hazardous Locations Classification
- X. NFPA 70E - Standard for Electrical Safety in Workplace

1.5 SUBMITTALS

- A. Product Data: Computer software program to be used for studies. Include specific software version for owner record.
- B. Product Certificates:
 - 1. Coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

2. Arc flash calculations computer software programs, certifying compliance with IEEE 1584.
- C. Qualification Data: For coordination study specialist.
 1. Submit qualifications of the organization proposed for performing the study. Include description of the equipment and computer-based computation methods or programs used and the names and experience histories of the personnel who will perform the study.
- D. Other Action Submittals: Subsequent to having approval for system protective devices submit the following in digital format (submit for review and approval by University previous to applying arc flash labels or have 3rd party testing firm implement coordination recommended settings):
 1. Electrical one-line drawing drafted in computer software program with component names.
 - a. Drawing maximum text height of 3/32". Maximum paper size 30"x42". Provide multiple drawing sheets as required.
 2. Fault current study report
 3. Equipment evaluation report
 4. Coordination study input data, including completed computer program input data sheets
 5. Coordination Study Report
 6. Arc Flash Study and Report
 7. Arc Flash labels
 8. Serving utility information with utility letterhead, including but not limited to:
 - a. Protective device part numbers/settings
 - b. Maximum available 1P and 3P fault
 - c. Line conductor sizes/lengths
 - d. Transformer impedance
 - e. Serving voltage
 9. Provide copy of Owner's electrical safety program if site specific standards vary from instructions noted in this project specification. All software files, including report documents and system study native files (including relevant library files), to allow review and future use of files
 10. Sample energized work permit form
 11. Provide thumb drive, or similar shared drive, with all SKM files created to complete power system study

1.6 QUALITY ASSURANCE

- A. Perform studies using SKM Analysis Software. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

- B. Coordination Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Perform study under the direct supervision and control of a Registered Professional Electrical Engineer licensed in the State of California, with a minimum of 5 years recent experience in performing protective device coordination studies, arc flash calculations, and electrical system analysis.
- C. Comply with IEEE 242 for short circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with IEEE 1584 for arc flash calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis of Design Product:
 - 1. SKM Systems Analysis, Inc.
 - 2. or equal

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399 and IEEE 1584.
- B. Analytical features of fault current study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399 Table 7-4.
- C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program reports device settings and ratings of all overcurrent protective devices and demonstrates selective coordination by computer-generated, time-current coordination plots.
- D. Arc Flash Calculations: Software program capable of calculating Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices for coordination are indicated on drawings.
- B. 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.
- C. Provide the study based on the actual electrical equipment supplied for the project.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with power riser diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance(s).
 - 3. Power Riser Diagrams: In hard copy and electronic copy formats, showing the following:
 - a. Circuit breaker and fuse-current ratings and types
 - b. Relays and associated power and current transformer ratings and ratios
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios
 - d. Generator kilovolt amperes, size, voltage, and source impedance
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length
 - 1) Prior to equipment purchase, utilize conservative lengths (up/down included) based on planned conduit routing to validate equipment ratings. Final study to utilize contractor provided as-built lengths to confirm equipment ratings.
 - f. Busway ampacity and impedance
 - g. Motor horsepower and code letter designation according to NEMA MG 1
 - h. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment
 - 4. Data sheets to supplement power riser diagrams, cross-referenced with tag numbers on diagrams, 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 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. Panelboards, switchboards, automatic transfer switch, switchgear ampacity, and interrupting rating in amperes rms symmetrical
 - 1) Automatic transfer switch withstand rating to comply with UL 1008. Equivalent trip curves are not accepted for specific breaker rated equipment - exact breaker and associated trip unit must be listed on UL certification.

3.3 FAULT CURRENT STUDY

- A. Calculate maximum available short circuit current in amperes rms symmetrical at circuit breaker positions of electrical power distribution system. Provide calculation for a current immediately after initiation and for a three-phase bolted short circuit at the following:
 1. Switchgear and switchboard bus
 2. Medium-voltage controller
 3. Motor control center
 4. Distribution panelboard
 5. Branch circuit panelboard
 6. Disconnect switches
 7. Automatic transfer switch
 8. Manual transfer switch
 9. Equipment fed by Variable Frequency Drive (VFD)

- B. For standard non-bypass Pulse Width Modulation VFDs, a line short circuit condition may be ignored.
- C. Verify mechanical equipment served meets or exceeds maximum short circuit available.
- D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for project. Include studies of system switching configurations and alternate operations that could result in maximum fault conditions.
 - 1. Model the entire electrical distribution system from utility company point of connection to circuit breakers in 208 V distribution panels at secondary side of distribution transformers. Include mechanical HVAC equipment, motor driven equipment feeder circuits, and elevator feeder circuits.
 - 2. Model shall include components of the distribution system which would be exposed to fault current levels of 10,000 A symmetrical on a calculated basis.
- E. Calculate momentary and interrupting duties on basis of maximum available fault current.
- F. Perform calculations to verify interrupting ratings of overcurrent protective devices in compliance with IEEE 241 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10
 - b. ANSI C57.12.22
 - c. ANSI C57.12.40
 - d. IEEE C57.12.00
 - e. IEEE C57.96
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1
 - 4. Low-Voltage Fuses: IEEE C37.46
- G. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (5-cycle) fault currents on power riser diagrams in report. List other output values from computer analyses, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage circuit breakers to set relays and assess the sensitivity of overcurrent relays.
- H. Equipment Evaluation Report:

1. Prepare report on adequacy of overcurrent protective devices and conductors by comparing fault current ratings of devices with calculated fault current momentary and interrupting duties.
2. For 600V overcurrent protective devices, ensure interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
3. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
4. Verify adequacy of phase conductors at maximum 3-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure short circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
5. Notify Owner's Representative promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution.
6. Under duty equipment will not be accepted. Series rating of equipment is not permitted.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault current study. Comply with IEEE 399.
 1. Calculate maximum and minimum 1/2-cycle short circuit currents.
 2. Calculate maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.
 3. Calculate maximum and minimum ground-fault currents.
- B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
- C. Comply with IEEE 241 IEEE 242 recommendations for fault currents and time intervals.
- D. Transformer Primary Overcurrent Protective Devices:
 1. Devices non-operational 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. Protect transformers according to IEEE C57.12.00, for fault currents by device settings.
- E. Protect motors served by voltages more than 600 V according to IEEE 620.
- F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32- 382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate

equipment withstands the maximum short circuit current for a 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. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

- G. Include voltage classes of equipment from utility's incoming line protective device down to and including each panelboard. The phase and ground overcurrent protection shall be included as well as settings for other adjustable protective devices.
- H. Selective Coordination: Overcurrent devices installed upstream and downstream of automatic transfer switches and/or associated with NEC Article 700 Emergency and 701 Legally Required loads shall be selectively coordinated from source of supply (both normal and emergency sources) through final device. Change specific circuit breakers (type, frame, trip-unit, etc.) and equipment bus rating as necessary to meet this requirement.
 - 1. Additionally, provide selective coordination for ground fault through-out.
- I. Coordination Study Report: Prepare a written report indicating results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values
 - c. Circuit breaker sensor rating; and long-time, short-time, and instantaneous settings
 - d. Fuse-current rating and type
 - e. Ground-fault relay-pickup and time-delay settings
 - f. Manufacturer and type of device
 - g. Range of adjustments and recommended settings
 - 2. Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate adequate time separation exists between devices installed in series, drawn to show the boundaries of device operation on log-log scale graphs, including power utility company's upstream devices. Where time current curves do not explicitly illustrate selective coordination but breakers have been tested and documented as being selectively coordinated, submit manufacturer's literature to substantiate device coordination. Include on curve sheet a title and legend identifying portion of the system covered. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

- a. Device tag
 - b. Voltage and current ratio for curves
 - c. Three-phase and single-phase damage points for each transformer
 - d. No damage, melting, and clearing curves for fuses
 - e. Cable damage curves
 - f. Transformer inrush points, full-load amps, and damage curves
 - g. Maximum fault current cutoff point
 - h. Generator decrement curve and full-load amps
3. Plot characteristics where applicable:
- a. Medium- and low- voltage fuses including minimum melt, total clearing and damage bands
 - b. Low-voltage circuit breaker trip devices
 - c. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 - d. Ground-fault protective devices
 - e. Motor starting characteristics and motor damage points
 - f. Generator short circuit decrement curve and generator damage point
 - g. Conductor damage curves
 - h. Electric utility's protective devices
 - i. Medium-voltage equipment relays
4. Notify Owner's Representative promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution. Propose approaches to effectively protect the underrated equipment. Present technical evaluation with discussion of logical compromises for best coordination.
- J. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

- A. Perform arc flash calculations for Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances. Utilize short circuit rating of equipment identified in fault current study - note infinite bus fault current alone is not acceptable.
- B. Model worst-case arc flash conditions
 1. Equipment with PPE rating greater than 2 shall be investigated. Investigation shall include adjustment of upstream overcurrent device settings to determine if PPE rating can be reduced with minimal compromise to coordination with other overcurrent devices.
- C. Arc Flash Study Report: Provide study results in tabular form and include:
 1. Device or bus name
 2. Bolted fault and arcing fault current levels 2
 3. Arc Flash Incident Energy (AFIE) level at 455 mm expressed in cal/cm

4. Flash protection boundary distances including:
 - a. Limited shock approach boundary
 - b. Restricted shock approach boundary
 5. Trip/Delay time
 6. Breaker opening time
 7. Working distance
 8. Equipment class and bus gap
 9. Personal protective equipment class (PPE)
- D. Provide recommendation for reducing AFIE levels and enhancing worker safety.

3.6 FIELD QUALITY CONTROL

- A. Inspect, set, test, and calibrate the protective relays, circuit breakers, fuses, and other applicable devices per requirements in Section 26 08 12 - Power Distribution Acceptance Tests and Section 26 08 13 - Power Distribution Acceptance Test Tables.
- B. Upon final approval of study, provide weatherproof vinyl or polyester arc flash label for all electrical equipment defined above. Label shall include calculated flash protection boundary, incident energy in cal/cm² at working distance (mm working distance based on equipment class, per IEEE 1584), required PPE level, limited approach, restricted approach, equipment name, company name/logo who performed the study, available fault current, overcurrent device settings if applicable, and date label was produced.
 1. Label to comply with ANSI Z535. Use "WARNING" (ANSI safety orange background with an orange exclamation point safety symbol) for all arc flash levels.
 2. Per NFPA 70E 130.5(C), due to use of incident energy analysis method, PPE categories shall not be provided on labels unless site specific standard PPE categories differ from incident energy levels noted in NFPA 70E Table 130.7(C)(16).
 3. Include verbiage on label noting study should be re-examined once every (5) years or upon modifications to electrical system.

3.7 ADJUSTING

- A. Make modifications to equipment, as required, to accomplish conformance with equipment evaluation study.
- B. Confirm that all electrical distribution equipment is rated for 110% of the fault duty that is applied per the evaluation study. All equipment must be fully rated. The use of series ratings to achieve sufficient duty is not acceptable.

- C. Adjust relay and overcurrent protective device settings according to recommended settings table provided by overcurrent protective device coordination study.
- D. Notify Owner's Representative in writing of any required major modifications.

3.8 INSTALLATION

- A. Install PPE labels on each piece of equipment prior to energizing equipment.
- B. PPE labels shall be protected by clear plastic cover, weatherproof type material, or laminated and mounted on front of equipment. Taping of PPE label to front of equipment is unacceptable.
- C. PPE label shall be clearly visible upon approach to equipment.
- D. For large pieces of equipment, label shall be placed near main overcurrent device or incoming feeder to equipment. For equipment such as switchboards, UPS, or switchgear, with multiple vertical sections, provide (1) label per vertical section.
- E. Contractor to provide one-line diagrams (meet IEEE/ANSI standard 141), mounted on 24"x36" (minimum) Styrofoam backboard. These one-line diagrams shall be mounted in each electrical room.
- F. Label shall be mounted at a minimum of 42" to bottom and maximum 66" to top above finished floor.
- G. Label shall be installed on all switchboards, distribution panelboard, panelboards, VFDs, disconnects, motor controllers, elevator controllers, lighting controllers, transformers with operable doors, and any other electrical equipment with hinged doors.

END OF SECTION 26 05 73

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SECTION 26 05 93 - ELECTRICAL SYSTEMS FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 07 84 13 - Penetration Firestopping
- B. Section 26 05 33 - Raceways and Boxes for Electrical Systems
- C. Section 26 05 36 - Cable Trays for Electrical Systems
- D. Section 26 25 00 - Enclosed Bus Assemblies

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions (walls, partitions, floors, and ceilings) including both empty openings and openings containing electrical penetrating items, including but not limited to raceways, cables, cable trays, busways, and wireways.

1.4 REFERENCE STANDARDS

- A. ASTM E-814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- B. UL 1479 - Fire Tests of Through-Penetration Firestops

1.5 PERFORMANCE REQUIREMENTS

- A. Provide firestop system to resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Firestop systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.
- C. Conform to applicable Code requirements of Authority Having Jurisdiction.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetration items, including documentation of UL certification for firestop systems.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Material Safety Data Sheets provided with product delivered to job site.
- E. Certification of compliance with Building Codes of the State California of Project location.
- F. Inspection reports
- G. Onsite Training Letter: Firestop manufacturer to provide and contractor to submit letter stating the names(s) of the companies, person(s) in attendance and date of onsite training as required in section 1.7.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.
- B. Firestopping tests shall be performed by a qualified testing and inspecting agency, or another agency performing testing and follow-up inspection services for firestop systems acceptable to Authorities Having Jurisdiction.
- C. Manufacturer's representative shall be on-site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and manufacturer, and UL Label where applicable.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
- C. Handle in accordance with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.

1.9 PROJECT CONDITIONS

- A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop systems' manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturers' written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through- penetration firestop systems.
- C. Notify Owner's Representative at least 7 days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's Representative.

1.11 SEQUENCING

- A. Sequence work to avoid interferences with building finishes and installation of other products.

1.12 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1 year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.13 LEED REQUIREMENTS

- A. The materials/products/methods specified in this section have an impact on the Project's LEED requirements. The General Contractor shall verify and document the contribution of the materials/products/methods provided to the Project's LEED requirements. This contribution shall be documented as specified in this section, Division 01 section Sustainable Architecture and LEED Requirements, Division 01 section Construction Waste Management, and as required in the [LEED 2009 for New Construction and Major Renovation, and errata] [LEED v4 Building Design and Construction: New Construction and Major Renovation, and errata]. LEED requirements impacted by this section are:
 - 1. Credit MR2: Construction Waste Management. See Division 01 Section Construction Waste Management for construction waste management requirements.
 - 2. Credit MR5: Regional Materials.
 - 3. Credit EQ4.1: Low Emitting Materials, Adhesives & Sealants.
 - 4. Credit EQ4.2: Low Emitting Materials, Paints & Coatings
 - 5. Prerequisite MR - Construction and Demolition Waste Management Planning
 - 6. Prerequisite MR - PBT Source Reduction - Mercury
 - 7. Credit MR - Building Product Disclosure and Optimization - Environmental Product Declarations
 - 8. Credit MR - Building Product Disclosure and Optimization - Sourcing of Raw Materials
 - 9. Credit MR - Building Product Disclosure and Optimization - Material Ingredients
 - 10. Credit MR - PBT Source Reduction - Mercury
 - 11. Credit MR - PBT Source Reduction - Lead, Cadmium, and Copper
 - 12. Credit MR - Construction and Demolition Waste Management
 - 13. Credit MR 4 - Recycled Content
 - 14. Credit MR 5 - Regional Materials
 - 15. Credit EQ - Low Emitting Materials]

PART 2 - PRODUCTS

2.1 LEED MATERIAL REQUIREMENTS

- A. Products and materials provided in this section shall comply with and contribute to the Project's LEED requirements. LEED requirements are as indicated in this section and as specified in Division 01 section Sustainable Architecture and LEED Requirements. Contributions to LEED requirements shall be documented as indicated in the submittals paragraph of this section and as specified in Division 01 section Sustainable Architecture and LEED Requirements]

2.2 MANUFACTURERS

- A. 3M (Fire Protection Products Division), Hilti Inc, Tremco (Sealant/Weatherproofing Division), Nelson Firestop Products, Specified Technologies Inc, RectorSeal Corporation, or equal.

2.3 MATERIALS

- A. Firestop Products: UL 1479, ASTM E-814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance; materials shall not contain flammable solvents.
- B. Firestop Systems: Produced by the same manufacturer.
- C. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L
 - 3. Sealant Primers for Porous Substrates: 775 g/L

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean out openings immediately prior to installing through-penetration firestop system to comply with firestop system manufacturer's written instructions.
- B. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- C. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3.3 INSTALLATION

- A. Comply with "System Performance Requirements" Article in Part 1 and with firestop system manufacturer's written installation instructions and drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during application as required. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Each conduit penetration through a fire rated assembly is to be dedicated to a single conduit. Multiple conduits penetrating a single opening is not acceptable unless a UL listed, multi-conduit assembly is used.

3.4 IDENTIFICATION

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include label(s) complying with 1 or 2 below.
 - 1. Custom label with the following information:
 - a. The words: "Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - b. Contractor's name, address, and phone number
 - c. Through-penetration firestop system designation of applicable testing and inspecting agency
 - d. Date of installation
 - e. Through-penetration firestop system manufacturer's name
 - f. Installer's name
 - 2. Manufacturer's preprinted labels with similar information per 1 above.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner's Representative will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
 - 1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.
- B. Provide certification by Installer that all through-penetration firestop systems have been firestopped in accordance with applicable Building Codes of the State California.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with specifications.

3.6 CLEANING

- A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION 26 05 93

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SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. System specific commissioning
 - 2. Electrical systems to be commissioned are as follows:
 - a. Occupancy sensors for lighting and/or HVAC,
 - b. Daylight/photocell controls (exterior or interior)
 - c. Other programmable lighting controls
 - d. Electrical metering systems
 - e. Interface with building energy management system (if applicable)
 - f. Emergency power systems (if applicable)

- B. Related Sections:
 - 1. 01 33 00 Division 1 Submittal procedures
 - 2. 01 77 00 Division 1 Close out procedures
 - 3. 01 78 23 Division 1 Operating and Maintenance Data
 - 4. 01 91 00 Division 1 Commissioning

1.2 DESCRIPTION OF WORK - REFER TO SECTION 01 91 00

1.3 SUBMITTALS - REFER TO SECTION 01 91 00

PART 2 - PRODUCTS - REFER TO SECTION 01 91 00

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS AND PROCEDURES - REFER TO SECTION 01 91 00

3.2 PRE-FUNCTIONAL CHECKLIST

- A. Pre-Functional Test is defined under Section 01 91 00. Only the sample checklists are provided in this section as an indication of the format and rigor of the required pre-functional checklists and documentation (refer to 260800 - Exhibit A). Though not developed specifically for this project, they show the extent of checks involved associated with typical installations. Actual Pre- Functional Checklist shall be prepared by the CA upon review of all the contractor submittals, including manufacturer's installation instructions.

- B. These checklists do not take the place of the manufacturer's recommended checkout and start-up procedures or report or those used by the Testing Agency.
- C. Regardless of whether the CA includes them or not, checks, inspections, safety measures, quality control measures and start-up procedures recommended by the manufacturer shall be implemented by the Contractor prior to initiation of the commissioning activity.
- D. The Commissioning Coordinator (CC) employed by the Contractor shall be responsible for directing all Pre-Functional Check lists provided by the CA. The CC shall engage subcontractors and vendors service representatives with expertise in the specific equipment or system to determine whether the equipment or system passes the checks detailed in the Pre- Functional Checklist.
- E. CC shall communicate the actual schedule for the execution of the Pre-Functional Checks to the CA as provided under Section 01 91 00.
- F. The Commissioning Authority (CA) may choose to participate in the inspection of items along with the Contractor and his specialty subcontractors and vendors, including the Testing Agency. In addition, CA reserves the right to inspect any or all of the items on his own in order to satisfy that the installation conforms to the design objectives and the system is ready for Functional Testing.
- G. For additional information on how the Pre-Functional Checklists fits within the overall framework of Commissioning as well as the Contractor's obligations under the same, please see Section 01 91 00.

3.3 FUNCTIONAL PERFORMANCE TESTING

- A. Contractor shall assist the Testing Agency and the Commissioning Authority (CA) in developing the Working Functional Performance Test (FPT) Procedures as specified in Section 01 91 00. Electrical Acceptance testing shall be generally based on specification and other procedures determined by the Testing Agency. For any given equipment or system, subcontractors and equipment suppliers associated with and specializing in the specific equipment are required to participate in developing the working procedures for the indicated FPTs. It is conceivable that for certain equipment and systems, multiple subcontractors and specialties may be required to participate to contribute to the development of the Functional Test. Contractor shall extend his full cooperation to the CA in securing the subcontractor or supplier resources necessary to develop and implement the Functional Tests.
- B. The Contractor's Commissioning Coordinator is required to manage the subcontractors in developing the Working FPT Procedures and Data Forms, and in performing all FPT's.

- C. Only the sample functional tests are provided in this section as an indication of the format and rigor of the required for functional tests and documentation (refer to 260800 - Exhibit B). Though not developed specifically for this project, they show the extent of checks involved associated with typical installations. Actual functional test reports for the project shall be prepared by the CA upon review of all the contractor submittals, including manufacturer's installation instructions.
- D. Contractor shall conduct functional tests for 100% of the systems to be commissioned shall be subject to the Functional Tests.
- E. CA shall develop the Functional Test following review of all contractor submittals. The Functional Test documents shall be made available to the immediately upon the successful completion of the Pre-Functional Check Lists and correction of all issues identified in the Pre- Functional Checklist.
- F. Refer to Section 01 91 00 for additional requirements regarding Functional Tests.

END OF SECTION 26 08 00

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SECTION 26 08 12 - POWER DISTRIBUTION ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 13.16 - Medium-Voltage, Single- and Multi-Conductor Cables
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- D. Section 26 05 73 - Power System Studies
- E. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
- F. Section 26 13 16 - Medium-Voltage Fusible Pad-Mounted Switchgear
- G. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
- H. Section 26 22 00 - Low-Voltage Transformers
- I. Section 26 23 00 - Low-Voltage Switchgear
- J. Section 26 24 13 - Switchboards
- K. Section 26 24 16.13 - Lighting and Appliance Panelboards
- L. Section 26 27 13 - Electrical Metering
- M. Section 26 28 16 - Enclosed Switches and Circuit Breakers
- N. Section 26 29 13 - Enclosed Controllers
- O. Section 26 32 13 - Engine Generators
- P. Section 26 36 23 - Automatic Transfer Switches

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes acceptance testing requirements for assessing the suitability for service and reliability of the power distribution system.
- B. Contractor to ensure all tested electrical equipment, both contractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- C. Tests and inspections shall be performed after installation.
- D. Tests and inspections shall determine suitability for energization.
- E. Electrical systems shall pass tests prior to substantial completion or Owner occupancy.
- F. This specification requires contractor to engage services of testing agency.
- G. All tests tables referenced in this specification are to standard NETA Power Distribution Acceptance Test Tables.
- H. Items to be tested and inspected as follows:
 - 1. 600-volt conductors and cables
 - 2. Medium-voltage cables
 - 3. Electrical metering
 - 4. Engine generator
 - 5. Dry type transformers (small)
 - 6. Dry type transformers (large)
 - 7. Liquid filled transformers
 - 8. Low-voltage switchgear
 - 9. Switchboard
 - 10. Medium-voltage metal-enclosed air switches
 - 11. Medium-voltage oil switches
 - 12. Medium-voltage air circuit breakers
 - 13. Medium-voltage vacuum circuit breakers
 - 14. Low-voltage power circuit breakers
 - 15. Low-voltage insulated-case/molded-case circuit breakers
 - 16. Low-voltage disconnect switches
 - 17. Medium-voltage SF6 circuit breakers
 - 18. Medium-voltage SF6 switches
 - 19. Medium-voltage surge arresters
 - 20. Network protectors (600 V class)
 - 21. Automatic transfer switches
 - 22. Motor control and motor control center

23. Metal-enclosed busways
24. Ground fault protection systems
25. Grounding systems
26. Protective relays (as applicable)
27. Instrument transformers
28. Thermographic survey

1.4 REFERENCE STANDARDS

- A. ANSI/IEEE C2 - National Electrical Safety Code
- B. ANSI/IEEE C37 - Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses
- C. ANSI/IEEE C37.04 - Standard Rating Structure for AC High Voltage Circuit Breaker
- D. ANSI/IEEE C57 - Distribution, Power, and Regulating Transformers
- E. ANSI/IEEE C57.13.1 - Guide for Field Testing of Relaying Current Transformers
- F. ANSI/IEEE C57.13.3 - Grounding of Instrument Transformer Secondary Circuits and Gases
- G. ANSI/IEEE C57.104 - Guide for the Interpretation of Gases Generated in Oil-immersed Transformers
- H. ANSI/IEEE C62 - Surge Protection
- I. ANSI/IEEE Std. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery
- J. ANSI/IEEE Std. 48 - Standard Test Procedure and Requirements for High-Voltage Alternating- Current Cable Terminations
- K. ANSI/IEEE Std. 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- L. ANSI/IEEE Std. 141 - IEEE Recommended Practice for Electrical/Power Distribution for Industrial Plants (IEEE Red Book)
- M. ANSI/IEEE Std. 142 - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)
- N. ANSI/IEEE Std. 241 - IEEE Recommended Practice for Electrical Power Systems in Commercial Buildings (IEEE Gray Book)

- O. ANSI/IEEE Std. 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
- P. ANSI/IEEE Std. 399 - IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book)
- Q. ANSI/IEEE Std. 400 - Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field
- R. ANSI/IEEE Std. 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)
- S. ANSI/IEEE Std. 493 - IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book)
- T. ANSI/IEEE Std. 1100 - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)
- U. ASTM D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- V. ASTM D823 - Standard Practices for Sampling Electrical Insulating Liquids
- W. ASTM D924 - Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
- X. ASTM D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Methods
- Y. ASTM D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration
- Z. ASTM D1298 - Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
- AA. ASTM 1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale) BB. ASTM D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Oils of
- BB. Petroleum Origin in the Field
- CC. ASTM D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes

- DD. ASTM D2285 - Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop-Weight Method
- EE. ASTM D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography
- FF. ASTM D3613 - Standard Practice for Sampling Insulating Liquids for Gas Analysis and Determination of Water Content
- GG. NETA - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
- HH. NEMA AB 4 - Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications
- II. NEMA MG1 - Motors and Generators
- JJ. NFPA 70 - National Electrical Code
- KK. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance
- LL. NFPA 70E - Electrical Safety Requirements for Employee Workplaces
- MM. NFPA 101 - Life Safety Code
- NN. NFPA 110 - Emergency and Standby Power Systems
- OO. NIST - National Institute of Standards and Technology
- PP. OSHA - Part 1910 - Subpart S - 1910.308 - Special Systems

1.5 SUBMITTALS

- A. Test Reports: Include the following:
 - 1. Summary of project
 - 2. Description of equipment tested
 - 3. Equipment used to conduct the test
 - 4. Description of test
 - 5. Test results, as compared to manufacturers' or industry accepted standards and tolerances
 - 6. Conclusions and recommendations
 - 7. Signature of responsible test organization authority
- B. List of equipment used to perform tests. Identify the following:
 - 1. Type

2. Manufacturer
3. Model number
4. Serial number
5. Date of last calibration
6. Documentation of calibration leading to NIST standards

1.6 QUALITY ASSURANCE

- A. Qualifications of Testing Agency:
1. Testing firm shall be a corporately and financially independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturer, supplier, and installers of equipment or system evaluated by the testing firm.
 2. Testing firm shall be regularly engaged in testing of electrical equipment, devices, installations and systems.
 3. Testing firm will be a member of NETA
 4. Testing firm shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories.
 5. The on-site test technician will possess a NETA Level 3 certification or greater.
 6. Testing firm shall use technicians who are regularly employed by the firm for testing services.
 7. Testing firm shall submit proof of above qualifications with bid documents when requested.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Documentation: Deliver the following to testing firm, minimum two weeks prior to commencement of testing:
1. Complete set of electrical plans and specifications, with available short circuit indicated on power riser diagrams.
 2. Approved submittals and shop drawings of equipment being tested.
 3. Pertinent change orders.
 4. Evaluation, overcurrent protective device coordination and arc flash studies, per requirements in Section 26 05 73 - Power System Studies.
- B. Schedule: Notify Owner's Representative 10 working days prior to performance of any tests.

- C. Coordination: Coordinate with Construction Manager/Owner's Representative the testing schedule and availability of equipment ready for testing.
- D. Test Power: Provide test power (including specialized) for equipment testing before and after service energizing.

3.2 FIELD QUALITY CONTROL

- A. Inspection and Test Procedures: Comply with NETA.
 - 1. 600 V Conductors and Cables:
 - a. Visual and Mechanical Inspection:
 - 1) Compare cable data with drawing and specifications.
 - 2) Inspect exposed sections of cables for physical damage.
 - 3) Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or NETA Table 12.
 - 4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
 - 5) Inspect compression-applied connectors for correct cable match and indentation.
 - 6) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.
 - 7) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.
 - 8) Inspect for correct identification and arrangements.
 - 9) Inspect jacket and insulation condition.
 - b. Electrical Tests:
 - 1) Perform insulation-resistance test using megohm meter. Applied potential to be 1000 VDC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.
 - 2) Perform continuity tests to insure correct cable connection.
 - c. Test Values:
 - 1) Insulation-resistance values should not be less than 50 megohms.
 - 2. Medium-Voltage Cables:
 - a. Visual and Mechanical Inspection:
 - 1) Compare cable date with drawings and specifications.
 - 2) Inspect exposed sections of cables for physical damage.
 - 3) Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with manufacturer's published data or NETA Table 12.

- 4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
 - 5) Inspect compression-applied connectors for correct cable match and indentation.
 - 6) Inspection for shield grounding, cable support, and termination.
 - 7) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.
 - 8) Inspect for adequate fireproofing in common cable areas, if specified.
 - 9) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed and shields are correctly terminated for operation of protective devices.
 - 10) Inspect jacket and insulation condition.
 - 11) Inspect for correct identification and arrangements.
- b. Electrical Tests:
- 1) Perform shield-continuity test on each power cable by ohmmeter method and record value.
 - 2) Perform insulation-resistance test using megohm meter with voltage output of at least 2500 V. Individually test each conductor with other conductors and shields grounded. Test duration shall be 1 minute.
 - 3) Perform DC high-potential test on cables, including terminations and joints after cable system installation and before placing cable in service. Adhere to precautions and limits as specified in applicable NEMA/ICEA Standards for the specific cable. Perform tests in accordance with ANSI/IEEE Standard 400. Test voltages shall not exceed 80% of cable manufacturer's factory test value or maximum test voltage in NETA Table 6.
 - a) Insure input voltage to test set is regulated.
 - b) Current-sensing circuits in test equipment shall measure only leakage current associated with cable under test and shall not include internal leakage of test equipment.
 - c) Record wet- and dry-bulb temperatures or relative humidity and temperature.
 - d) Test each section of cable individually.
 - e) Individually test each conductor with other conductors grounded. Ground shields.
 - f) Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable method as necessary.
 - g) Insure maximum test voltage does not exceed limits for terminators specified in ANSI/IEEE Standard 48 or manufacturer's specifications.

- h) Apply DC high-potential test in at least 5 equal increments until maximum test voltage is reached. No increment shall exceed voltage rating of the cable. Record DC leakage current at each step after constant stabilization time consistent with system charging current.
 - i) Raise conductor to specified maximum test voltage and hold for 15 minutes on shielded cable and 5 minutes on non-shielded cable. Record readings of leakage current at 30 seconds and one minute and at one- minute intervals thereafter.
 - j) Reduce conductor test potential to zero and measure residual voltage at discrete intervals.
 - k) Apply grounds for time period adequate to drain insulation stored charge.
 - l) When new cables are spliced into existing cables, DC high-potential test shall be performed on new cable prior to splicing in accordance with this section. After test results are approved for new cable and splice is complete, perform insulation-resistance test and shield-continuity test on the length of new and existing cable including the splice. After satisfactory insulation-resistance test, DC high-potential test shall be performed on cable using test voltage acceptable to Owner's Representative and not exceeding 60% of factory test value.
- c. Test Values:
- 1) Shielding must exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 ft of cable.
 - 2) Graphic plots may be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.
 - a) Step voltage slope should be reasonably linear.
 - b) Capacitive and absorption current should decrease continually until steady state leakage is approached.
3. Electrical Metering:
- a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify tightness of electrical connections.
 - 4) Inspect cover gasket, cover glass, condition of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
 - 5) Verify freedom of movement, correct travel and alignment, and tightness of mounting hardware.
 - b. Electrical Tests:

- 1) Check calibration of meters at cardinal points.
 - 2) Calibrate watt-hour meters according to manufacturer's published data.
 - 3) Verify instrument multipliers.
 - 4) Electrically confirm current transformer and voltage transformer secondary circuits are intact.
4. Dry Type Transformers (Large):
- a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify control and alarm settings on temperature indicators are as specified.
 - 4) Verify cooling fans operate correctly and fan motors have correct overcurrent protection.
 - 5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA Table 12.
 - 6) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
 - 7) Perform specific inspections and mechanical tests as recommended by manufacturer.
 - 8) Make a close examination of shipping brackets or fixtures that may not have been removed during installation. Insure resilient mounts are free.
 - 9) Verify seismic bracing is correct.
 - 10) Verify winding core, frame, and enclosure grounding are correct.
 - 11) Verify as-lift tap connections are as specified.
 - b. Electrical Tests:
 - 1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with NETA Table 5.
 - 2) Calculate polarization index.
 - 3) Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's instructions.
 - 4) Perform turns-ratio test on tap connections. Verify winding polarities are in accordance with nameplate.
 - 5) Perform an excitation-current test on each phase.
 - 6) Measure resistance of each winding at each tap connection.
 - 7) Verify core is solidly grounded. If core is insulated and removable core ground strap is available, perform core insulation-resistance test at 500 VDC.

- 8) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
- c. Test Values:
 - 1) Bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by manufacturer.
 - 2) Insulation-resistance test values at one minute should not be less than values recommended in NETA Table 5. Results shall be temperature corrected in accordance with NETA Table 14.
 - 3) Polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
 - 4) Turns-ratio test results should not deviate more than 0.5% from either adjacent coils or calculated ratio.
 - 5) CH and CL dissipation-factor/power-factor values will vary due to support insulators and bus work used on dry transformers. The following should be expected on CHL power factors:
 - a) Power Transformers: 2% or less
 - b) Distribution Transformers: 5% or less
 - 6) Consult transformer manufacturer's or test equipment manufacturer's data for additional information.
 - 7) If winding-resistance test results vary more than 1% from adjacent windings, consult manufacturer.
 - 8) Typical excitation current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.
 - 9) If core insulation resistance is less than one megohm at 500 VDC, consult manufacturer.
5. Low-Voltage Switchgear and Switchboard Assemblies:
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Confirm correct application of manufacturer's recommended lubricants.
 - 4) Verify appropriate anchorage, required area clearances, grounding and correct alignment.
 - 5) Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
 - 6) Verify fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to circuit breaker's address for microprocessor- communication packages.

- 7) Verify that current and potential transformer ratios correspond to drawings.
 - 8) Verify tightness of accessible bolted electrical connections by calibrated torque- wrench. Refer to manufacturer's published data or NETA Table 12 for proper torque values.
 - 9) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
 - 10) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
 - b) Make key exchange with devices operated in off-normal positions.
 - 11) Inspect insulators for evidence of physical damage or contaminated surfaces.
 - 12) Verify correct barrier and shutter installation and operation.
 - 13) Exercise active components.
 - 14) Inspect mechanical indicating devices for correct operation.
 - 15) Verify filters are in place and/or vents are clear.
 - 16) Perform visual and mechanical inspection of instrument transformers, in accordance with paragraph "Instrument Transformers."
 - 17) Inspect control power transformers.
 - a) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - b) Verify that primary and secondary fuse ratings or circuit breakers match drawings.
 - c) Verify correct functioning of draw-out disconnecting and grounding contacts and interlocks.
- b. Electrical Tests:
- 1) Perform tests on all instrument transformers in accordance with paragraph "Instrument Transformers."
 - 2) Perform resistance tests through bus joints with low-resistance ohmmeter. Joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
 - 3) Perform insulation-resistance tests in each bus section, phase-to-phase and phase-to-ground for one minute in accordance with NETA Table 1.
 - 4) Perform over-potential test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. In the absence of any published data,

- NETA Table 2 shall apply. Test voltage shall be applied for one minute.
- 5) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendation.
 - 6) Perform current injection tests on the entire current circuit in each section of switchgear.
 - a) Perform current tests by primary injection, where possible, with magnitudes such that minimum of 1.0 amp flows in secondary circuit.
 - b) Where primary injection is impractical, utilize secondary injection with minimum current of 1.0 amp.
 - c) Test current at each device.
 - 7) Determine accuracy of meters and calibrate watt-hour meters in accordance with paragraph "Electrical Metering." Verify multipliers.
 - 8) Perform phasing check on double-ended switchboard/switchgear to insure correct bus phasing from each source.
 - 9) Perform the following tests on control power transformers:
 - a) Perform insulation-resistance tests. Perform measurements from winding- to-winding and each winding-to-ground. Test voltages shall be in accordance with NETA Table 1 unless otherwise specified by manufacturer.
 - b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
 - c) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
 - d) Verify correct function of control transfer relays located in switchboard/switchgear with multiple control power sources.
 - 10) Potential Transformer Circuits:
 - a) Perform insulation-resistance tests. Perform measurements from winding- to-winding and each winding-to-ground. Test voltages shall be in accordance with NETA Table 1, unless otherwise specified by manufacturer.
 - b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage.
 - c) Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.

- 11) Verify operation of switchgear/switchboard space heaters.
- c. Test Values:
 - 1) Bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by manufacturer.
 - 2) Compare bus connection resistances to values of similar connections.
 - 3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA Table 1. Values of insulation resistance less than this table or manufacturer's minimum should be investigated. Over-potential tests should not proceed until insulation- resistance levels are raised above minimum values.
 - 4) Bus insulation shall withstand the over-potential test voltage applied.
 - 5) Contact resistance values shall not exceed high limit of normal range as indicated in manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from similar bus by more than 50% of lowest value.
6. Low-Voltage Power Circuit Breakers:
 - a. Visual and Mechanical Inspection:
 - 1) Compare nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical conditions.
 - 3) Confirm correct application of manufacturer's recommended lubricants.
 - 4) Inspect anchorage, alignment, and grounding.
 - 5) Inspect arc chutes.
 - 6) Inspect moving and stationary contacts for condition, wear, and alignment.
 - 7) Verify maintenance devices are available for serving and operating breaker.
 - 8) Verify primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
 - 9) Perform mechanical operator and contact alignment tests on breaker and its operating mechanism.
 - 10) Verify tightness of accessible bolted bus connections by calibrated torque- wrench method. Refer to manufacturer's instructions or NETA Table 12 for correct torque levels.
 - 11) Perform thermographic survey of accessible bolted bus connections in accordance with paragraph "Thermographic Survey."
 - 12) Check cell fit and element alignment.
 - 13) Check racking mechanism.
 - 14) Record as-found and as-left operation-counter readings.
 - b. Electrical Tests:

- 1) Perform contact-resistance test.
 - 2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Test duration shall be one minute. Use a minimum test voltage in accordance with NETA Table 1 or manufacturer's published data.
 - 3) Perform insulation-resistance test at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform test on wiring connected to solid-state components. Follow manufacturer's recommendation.
 - 4) Make adjustments for final trip settings in accordance with overcurrent protective device coordination study.
 - 5) Determine minimum pickup current by primary current injection.
 - 6) Determine long-time delay by primary current injection.
 - 7) Determine short-time pickup and delay by primary current injection.
 - 8) Determine ground-fault pickup and delay by primary current injection.
 - 9) Determine instantaneous pickup value by primary current injection.
 - 10) Verify trip unit calibrations by secondary injection.
 - 11) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to insure operation of shunt trip devices. Check operation of electrically operated breakers in their cubicles. Perform minimum operation voltage on shunt trip and close coils in accordance with NETA Table 20.
 - 12) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrically close and trip operations, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.
 - 13) Check charging mechanism.
 - 14) Determine minimum operation voltage on shunt trip and close coils in accordance with NETA Table 20.
- c. Test Values:
- 1) Bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by manufacturer.
 - 2) Compare microhm or millivolt drop values to adjacent poles or similar breakers. Investigate deviations of more than 50% of the lowest value. Investigate any value exceeding manufacturer's recommendations.
 - 3) Circuit breaker insulation resistance shall be in accordance with NETA Table 1.
 - 4) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use

- NETA Table 1. Values of insulation-resistance less than this table or manufacturer's minimum shall be investigated.
- 5) Trip characteristics of breakers shall fall within manufacturer's published time- current tolerance bands.
 - 6) Minimum operation voltages on shunt trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to NETA Table 20.
7. Low-Voltage Insulated-Case/Molded-Case Circuit Breakers, 225A and Larger:
- a. Visual and Mechanical Inspection:
 - 1) Compare nameplate date with drawings and specifications.
 - 2) Inspect circuit breaker for correct mounting.
 - 3) Check cell fit, element alignment and racking mechanism for draw-out breakers.
 - 4) Operate circuit breaker to insure smooth operation.
 - 5) Inspect case for cracks or other defects.
 - 6) Verify tightness of accessible bolted electrical connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA Table 12.
 - 7) Inspect mechanism contacts and arc chutes in unsealed units.
 - b. Electrical Tests:
 - 1) Perform a contact-resistance test.
 - 2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Test duration shall be one minute. Use a minimum test voltage in accordance with NETA Table 1 or manufacturer's published data.
 - 3) Perform insulation-resistance test at 1000 VDC on all control wiring. Test duration shall be one minute. Do not perform the test on wiring connected to solid-state components. Follow manufacturer's recommendation.
 - 4) Perform adjustments for final trip settings in accordance with overcurrent protective device coordination study.
 - 5) Perform long-time delay time-current characteristic tests by passing 300% rated current through each pole separately, unless series testing is required to defeat ground fault functions.
 - 6) Determine short-time pickup and delay by primary current injection.
 - 7) Determine ground-fault pickup and time delay by primary current injection.
 - 8) Determine instantaneous pickup current by primary injection using run-up or pulse method.

- 9) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
- 10) Verify trip unit calibrations by secondary injection.
- 11) Determine minimum operation voltage on shunt trip and close coils in accordance with NETA Table 20.
- 12) Check charging mechanism.
- c. Test Values:
 - 1) Bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by manufacturer.
 - 2) Compare microhm or millivolt drop values to adjacent poles or similar breakers. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
 - 3) Circuit breaker insulation-resistance shall be in accordance with NETA Table 1.
 - 4) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use NETA Table 1. Values of insulation resistance less than this table or manufacturer's minimum shall be investigated.
 - 5) Trip characteristic of breakers shall fall within manufacturer's published time- current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA Table 7. Circuit breakers exceeding specified trip time at 300% of pickup shall be tagged defective.
 - 6) For molded-case circuit breakers, instantaneous pickup values shall be within manufacturer's published data or tolerances shown in NETA Table 8.
 - 7) Minimum operation voltages on shunt trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to NETA Table 20.
8. Low-Voltage Disconnect Switches:
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, grounding, and required clearances.
 - 4) Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
 - 5) Verify that fuse sizes and types are in accordance with drawings, short-circuit and overcurrent protective device coordination studies.

- 6) Verify that each fuse has adequate mechanical support and contact integrity.
 - 7) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA Table 12.
 - 8) Perform thermographic survey of accessible bolted electrical connection in accordance with paragraph "Thermographic Survey."
 - 9) Verify operation and sequencing of interlocking systems.
 - 10) Verify correct phase barrier installation.
 - 11) Verify correct operation of all indicating and control devices.
 - 12) Confirm correct application of manufacturer's recommended lubricants.
- b. Electrical Tests:
- 1) Measure contact resistance across each switchblade and fuse holder.
 - 2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground. Test duration shall be one minute. Use a minimum test voltage in accordance with NETA Table 1 or manufacturer's published data.
 - 3) Measure fuse resistance.
 - 4) Perform ground fault test, if applicable.
- c. Test Values:
- 1) Compare bolted connection resistances to values of similar connections.
 - 2) Bolt-torque levels should be in accordance with NETA Table 12, unless otherwise specified by the manufacturer.
 - 3) Compare microhm or millivolt drop values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
 - 4) Minimum insulation-resistance shall be in accordance with manufacturer's published data or NETA Table 1.
 - 5) Investigate fuse-resistance values that deviate from each other by more than 15%.
9. Network Protectors - 600V Class:
- a. Visual and Mechanical Inspection:
- 1) Open protector and rack it out of enclosure. Note network bus and transformer generally will be energized. Exercise extreme caution. Observe clearance and check for smoothness of operation when racking.
 - 2) Compare equipment nameplate data with drawings and specifications.
 - 3) Inspect physical and mechanical condition.

- 4) Inspect anchorage, alignment and grounding.
 - 5) Confirm correct application of manufacturer's recommended lubricants.
 - 6) Inspect enclosure door gasket and sight glass for damage.
 - 7) Inspect interior of enclosure for debris or damaged components. Inspect insulating components, current-carrying parts, and secondary disconnecting devices. Exercise extreme caution when working around network bus conductors.
 - 8) Check for missing parts on protector. Check tightness of electrical and mechanical connections. Tighten as necessary according to manufacturer's published data.
 - 9) Inspect insulating barriers for damage and correct mounting.
 - 10) Inspect network protector fuse covers, fuses, and blown fuse indicators for damage. Inspect closing motor brushes and commutator surface for damage. Inspect motor brake mechanism, if applicable.
 - 11) Remove and inspect arc chutes for damage.
 - 12) Verify sequence of main and arcing contacts by slow-closing protector. Adjust as necessary according to manufacturer's published data.
 - 13) Manually open and close protector and verify mechanism latches correctly in each position. Verify correct operation of position indicator.
 - 14) Verify electrical connections to network and auxiliary relays. Inspect electromechanical relays for freedom of movement of internal parts.
 - 15) Verify electrical connections to auxiliary switches, secondary disconnects, current transformers, voltage transformers, control power transformers, closing motors, contactors, trip coils, loading resistors, and other auxiliary devices.
 - 16) Record the as-found and as-left operations-counter reading.
 - 17) Perform leak test on submersible enclosure in accordance with manufacturer's published data.
- b. Electrical Tests:
- 1) Perform insulation-resistance tests on each pole, phase-to-phase and phase- to- ground with protector closed and across each open pole. Test duration shall be one minute. Test voltage shall be in accordance with NETA Table 1 or manufacturer's published data.
 - 2) Perform insulation-resistance tests at 1000 VDC for one minute on control wiring and electromechanical components. For units with solid-state components, follow manufacturer's recommendations.

- 3) Verify current transformer ratios in accordance with paragraph "Instrument Transformers."
 - 4) Measure contact resistance.
 - 5) Measure resistance of each protector power fuse.
 - 6) Measure minimum pickup voltage of motor control relay.
 - 7) Verify motor can charge closing mechanism at minimum voltage specified by manufacturer.
 - 8) Measure minimum pickup voltage of trip actuator. Verify actuator resets correctly.
 - 9) Calibrate network protector relays in accordance with paragraph "Protective Relays."
 - 10) Verify phase rotation, phasing and synchronized operation as required by the application.
 - 11) Perform operational tests:
 - a) Verify correct operation of mechanical and electrical interlocks.
 - b) Verify trip-free operation.
 - c) Verify correct operation of auto-open-close control handle.
 - d) Verify protector will close with voltage on transformer side only.
 - e) Verify protector will open when source feeder breaker is opened.
- c. Test Values:
- 1) Insulation-resistance of protector components shall be in accordance with NETA Table 1.
 - 2) Bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by the manufacturer.
 - 3) Control wiring insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA Table 1. Values of insulation-resistance less than this table or manufacturer's minimum should be investigated.
 - 4) Contact resistance shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, compare contact resistance to adjacent poles or similar protectors. Investigate deviations of more than 50% of the lowest value.
 - 5) Fuse resistance values shall not deviate by more than 15% of the lowest reading.
 - 6) Minimum voltage to operate trip actuator shall not exceed 7.5% of rated control circuit voltage.
 - 7) Minimum acceptable motor-closing voltage shall not exceed 75% of rated control circuit voltage.
 - 8) Network protector should automatically close upon closing feeder breaker with normal load demand and automatically trip when source feeder breaker is opened.

10. Metal Enclosed Busways:
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect busway for physical damage and correct connection in accordance with single-line diagram.
 - 3) Inspect for appropriate bracing, suspension, alignment, and enclosure ground.
 - 4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA Table 12.
 - 5) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey".
 - 6) Confirm physical orientation in accordance with manufacturer's labels to insure adequate cooling.
 - 7) Examine outdoor busway for removal of "weep-hole" plugs, if applicable, and correct installation of joint shield.
 - b. Electrical Tests:
 - 1) Measure insulation resistance of each busway, phase-to-phase and phase-to-ground for one minute, in accordance with NETA Table 1.
 - 2) Perform over-potential test on each busway, phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. Test voltage shall be applied for one minute. If manufacturer has recommendation for this test, it shall be in accordance with NETA Table 17.
 - 3) Perform contact-resistance test on each connection point of non-insulated busway. On insulated busway, measure resistance of assembled busway section and compare values to adjacent phase.
 - 4) Perform phasing test on each busway tie section energized by separate sources. Tests must be performed from their permanent sources.
 - 5) Verify operation of busway space heaters.
 - c. Test Values:
 - 1) Bus bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by manufacturer.
 - 2) Insulation-resistance test voltages and resistance values shall be in accordance with manufacturer's specifications or NETA Table 1. Minimum resistance values are for nominal 1000 ft busway run or megohms for 1000 ft. For busway runs over 1000 ft, convert the measured resistance value to the 1000 ft nominal value:
 - a) $R_{1000\text{ ft}} = \text{Measured Resistance} \times \text{Length of Run} / 1000\text{ ft}$

- 3) Values of insulation-resistance less than NETA Table 1 or manufacturer's minimum should be investigated. Over-potential tests should not proceed until insulation- resistance levels are raised above minimum values.
 - 4) Over-potential test voltages shall be applied in accordance with manufacturer's recommendations. Insulation shall withstand over-potential test voltage applied.
11. Ground Fault Protection Systems:
- a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Visually inspect components for damage and errors in polarity or conductor routing:
 - a) Verify ground connection is made ahead of neutral disconnect link and online side of any ground fault sensor.
 - b) Verify neutral sensors are connected with correct polarity on both primary and secondary.
 - c) Verify all phase conductors and neutral pass through sensor in same direction for zero sequence systems.
 - d) Verify grounding conductors do not pass through zero sequence sensors.
 - e) Verify grounded conductor is solidly grounded.
 - 3) Verify tightness of accessible bolted electrical connections, including control circuits, by calibrated torque-wrench method in accordance with manufacturer's published data or NETA Table 12.
 - 4) Verify correct operation of self-test panel.
 - 5) Set pickup and time-delay settings in accordance with settings provided on drawings and in specifications. Record operation and test sequences as required by NFPA 70.
 - 6) Verify the control power transformer has adequate capacity for the system.
 - b. Electrical Tests:
 - 1) Measure system neutral-to-ground insulation resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after testing.
 - 2) Perform insulation-resistance test of control wiring at 1000 VDC for one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.
 - 3) Perform the following pickup tests using primary injection:
 - a) Verify relay does not operate at 90% of pickup setting.
 - b) Verify pickup is less than 125% of setting or 1200 amp, whichever is smaller.

- 4) For summation type systems using phase-neutral current transformers, verify correct polarities by applying current to each phase-neutral current transformer pair. This test also applies to molded-case breakers using external neutral current transformer.
 - a) Relay should operate when current direction is the same relative to polarity marks in the two current transformers.
 - b) Relay should not operate when current direction is opposite relative to polarity marks in the two current transformers.
 - 5) Measure time delay of the relay at 150% or greater of pickup.
 - 6) Verify reduced voltage tripping capability: 55% for AC systems and 80% for DC systems.
 - c. Test Values:
 - 1) System neutral-to-ground insulation shall be minimum of one megohm.
 - 2) Insulation resistance values shall be in accordance with NETA Table 1.
 - 3) Relay timing shall be in accordance with manufacturer's specifications but must also be no longer than one second at 3000 amp.
 - 4) Bus bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by manufacturer.
12. Grounding Systems:
- a. Visual and Mechanical Inspection:
 - 1) Verify ground system is in compliance with drawings, specifications, and NFPA 70.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage.
 - b. Electrical Tests:
 - 1) Perform 3 point fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on all newly established grounding electrode systems.
 - 2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
 - 3) Make resistance measurements in dry weather not earlier than 48 hours after rainfall.
 - c. Test Values:
 - 1) The resistance between the main grounding electrode and ground should be no greater than five ohms. (Reference ANSI/IEEE 142.) Investigate any values above five ohms and notify Owner's Representative immediately for further instructions.
 - 2) Investigate point-to-point resistance values that exceed 0.5 ohm.
13. Protective Relays (as applicable):
- a. Visual and Mechanical Inspection:

- 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect relays and cases for physical damage. Remove shipping restraint material.
 - 3) Tighten case connectors. Inspect cover for correct gasket seal. Clean cover glass. Inspect shorting hardware, connection paddles, and knife switches. Remove foreign material from case. Verify target reset.
 - 4) Inspect relay for foreign material, particularly in disc slots of damping and electromagnets. Verify disk clearance. Verify contact clearance and spring bias. Inspect spiral spring convolutions. Inspect disk and contacts for freedom of movement and correct travel. Verify tightness of mounting hardware and connections. Burnish contacts. Inspect bearings and pivots.
 - 5) Set relays in accordance with coordination study supplied.
- b. Electrical Tests:
- 1) Perform insulation-resistance test on each circuit-to-frame. Determine from manufacturer's instructions allowable procedures for this test for solid-state and microprocessor-based relays.
 - 2) Inspect targets and indicators. Determine pickup and dropouts of electromechanical targets. Verify operation of light-emitting diode indicators. Set contrast for liquid-crystal display readouts.
 - 3) Functional Operation:
 - a) IEEE 2/62 Timing Relay
 - (1) Determine time delay.
 - (2) Verify operation of instantaneous contacts.
 - b) IEEE 21 Distance Relay
 - (1) Determine maximum reach.
 - (2) Determine maximum torque angle.
 - (3) Determine offset.
 - (4) Plot impedance circle.
 - c) IEEE 24 V/Hz Relay
 - (1) Determine pickup frequency at rated voltage.
 - (2) Determine pickup frequency at second voltage level.
 - (3) Determine time delay.
 - d) IEEE 25 Sync Check Relay
 - (1) Determine closing zone at rated voltage.
 - (2) Determine maximum voltage differential that permits closing at zero degrees.
 - (3) Determine live line, live bus, dead line, and dead bus set points.
 - (4) Determine time delay.

- (5) Verify dead bus/live line, dead line/live bus and dead bus/dead line control functions.
- e) IEEE 27 Undervoltage Relay
 - (1) Determine dropout voltage.
 - (2) Determine time delay.
 - (3) Determine time delay at second point on timing curve for inverse time relays.
- f) IEEE 32 Directional Power Relay
 - (1) Determine minimum pickup at maximum torque angle.
 - (2) Determine closing zone.
 - (3) Determine maximum torque angle.
 - (4) Determine time delay
 - (5) Verify time delay at second point on timing curve for inverse time relays.
 - (6) Plot operating characteristic.
- g) IEEE 40 Loss of Field (Impedance) Relay
 - (1) Determine maximum reach.
 - (2) Determine maximum torque angle.
 - (3) Determine offset.
 - (4) Plot impedance circle.
- h) IEEE 46 Current Balance Relay
 - (1) Determine pickup of each unit.
 - (2) Determine percent slope.
 - (3) Determine time delay.
- i) IEEE 46N Negative Sequence Current Relay
 - (1) Determine negative sequence alarm level.
 - (2) Determine negative sequence minimum trip level.
 - (3) Determine maximum time delay.
 - (4) Verify two points on $(I_2)^2t$ curve.
- j) IEEE 47 Phase Sequence or Phase Balance Voltage Relay
 - (1) Determine positive sequence voltage to close normally open contact.
 - (2) Determine positive sequence voltage to open normally closed contact (undervoltage trip).
 - (3) Verify negative sequence trip.
 - (4) Determine time delay to close normally open contact with sudden application of 120% of pickup.
 - (5) Determine time delay to close normally closed contact upon removal of voltage when previously set to rated system voltage.
- k) IEEE 49R Thermal Replica Relay
 - (1) Determine time delay at 300% of setting.

- (2) Determine second point on operating curve.
- (3) Determine pickup.
- l) IEEE 49T Temperature (RTD) Relay
 - (1) Determine trip resistance.
 - (2) Determine reset resistance.
- m) IEEE 50 Instantaneous Overcurrent Relay
 - (1) Determine pickup.
 - (2) Determine dropout.
 - (3) Determine time delay.
- n) IEEE 51 Time Overcurrent
 - (1) Determine minimum pickup.
 - (2) Determine time delays at 2 points on time current curve.
- o) IEEE 55 Power Factor Relay
 - (1) Determine tripping angle.
 - (2) Determine time delay.
- p) IEEE 59 Overvoltage Relay
 - (1) Determine overvoltage pickup.
 - (2) Determine time delay to close contact with sudden application of 120% of pickup.
- q) IEEE 60 Voltage Balance Relay
 - (1) Determine voltage difference to close contacts with one source at rated voltage.
 - (2) Plot operating curve for relay.
- r) IEEE 63 Transformer Sudden Pressure Relay
 - (1) Determine rate-of-rise or pickup level of suddenly applied pressure in accordance with manufacturer's specifications.
 - (2) Verify operation of 63 FPX seal-in circuit.
 - (3) Verify trip circuit to remote breaker.
- s) IEEE 64 Ground Detector Relay
 - (1) Determine maximum impedance to ground causing relay pickup.
- t) IEEE 67 Directional Overcurrent Relay
 - (1) Determine directional unit minimum pickup at maximum torque angle.
 - (2) Determine closing zone.
 - (3) Determine maximum torque angle.
 - (4) Plot operating characteristics.
 - (5) Determine overcurrent unit pickup.
 - (6) Determine overcurrent unit time delay at 2 points on time current curve.
- u) IEEE 79 Reclosing Relay

- (1) Determine time delay for each programmed reclosing interval.
 - (2) Verify lockout for unsuccessful reclosing.
 - (3) Determine reset time.
 - (4) Determine close pulse duration.
 - (5) Verify instantaneous overcurrent lockout.
 - v) IEEE 81 Frequency Relay
 - (1) Verify frequency set points.
 - (2) Determine time delay.
 - (3) Determine undervoltage cutoff.
 - w) IEEE 85 Pilot Wire Monitor
 - (1) Determine overcurrent pickup.
 - (2) Determine undercurrent pickup.
 - (3) Determine pilot wire ground pickup level.
 - x) IEEE 87 Differential
 - (1) Determine operating unit pickup.
 - (2) Determine operation of each restraint unit.
 - (3) Determine slope.
 - (4) Determine harmonic restraint.
 - (5) Determine instantaneous pickup.
 - (6) Plot operating characteristics for each restraint.
 - c. Control Verification:
 - 1) Verify each relay contact performs its intended function in control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions.
 - 2) For microprocessor-based relays, verify all inputs, outputs, internal logic, and timing elements used in protection, metering, and control functions.
 - d. Systems Tests:
 - 1) After the equipment is energized, measure magnitude and phase angle of inputs and compare to expected values.
 - e. Test Values:
 - 1) When not otherwise specified, use manufacturer's recommended tolerances.
 - 2) When critical test points are specified, relay should be calibrated to those points even though other test points may be out of tolerance.
- 14. Instrument Transformers:
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Verify correct connection of transformers with system requirements.

- 4) Verify adequate clearance between primary and secondary circuit wiring.
 - 5) Verify tightness of accessible bolted electrical connections by calibrated torque- wrench method in accordance with manufacturer's published data or NETA Table 12.
 - 6) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
 - 7) Verify required grounding and shorting connections provide contact.
 - 8) Verify correct operation of transformer withdrawal mechanism and grounding operation.
 - 9) Verify correct primary and secondary fuse sizes for potential transformers.
 - 10) Confirm correct application of manufacturer's recommended lubricants.
- b. Electrical Tests - Current Transformers:
- 1) Perform insulation-resistance test of current transformer and wiring-to-ground at 1000 VDC. Do not perform this test on wiring connected to units with solid- state components. Follow manufacturer's recommendations.
 - 2) Perform polarity test of each current transformer.
 - 3) Perform ratio-verification test using voltage or current method in accordance with ANSI/IEEE C57.13.1.
 - 4) Perform excitation test on transformers used for relaying applications in accordance with ANSI/IEEE C57.13.1.
 - 5) Measure current circuit burdens at transformer terminal and determine total burden.
 - 6) When applicable, perform insulation-resistance and dielectric withstand tests on primary winding with secondary grounded. Test voltages shall be in accordance with NETA Tables 5 and 9 respectively.
 - 7) Verify that current circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3.
- c. Electrical Tests - Voltage Transformers:
- 1) Perform insulation-resistance tests winding-to-winding and each winding-to- ground. Test voltages shall be applied for one minute in accordance with NETA Table 5. For units with solid-state components, follow manufacturer's recommendation.
 - 2) Perform polarity test on each transformer to verify polarity marks or H1-X1 relationship as applicable.
 - 3) Perform turns ratio test on all tap positions, if applicable.
 - 4) Measure potential circuit burdens at transformer terminals and determine total burden.

- 5) Perform dielectric withstand test on primary windings with secondary windings connected to ground. Dielectric voltage shall be in accordance with NETA Table 9. Test voltage shall be applied for one minute.
- d. Test Values:
 - 1) Insulation-resistance measurement on instrument transformer shall not be less than that shown in NETA Table 5.
 - 2) Bolt-torque levels shall be in accordance with NETA Table 12, unless otherwise specified by the manufacturer.
 - 3) Polarity results shall agree with system drawings.
 - 4) Compare measured burdens to calculated burdens supplied by Owner's Representative.
 - 5) Ratio accuracies shall be within 0.5% of nameplate or manufacturer's published data.
 - 6) Insulation shall withstand over-potential test voltage applied.
15. Thermographic Survey:
 - a. Visual and Mechanical Inspection:
 - 1) Inspect physical, electrical, and mechanical conditions.
 - 2) Remove all necessary covers prior to thermographic inspection.
 - 3) Equipment to be inspected shall include all current-carrying devices. Provide report including the following:
 - a) Discrepancies.
 - b) Temperature difference between area of concern and reference area.
 - c) Cause of temperature difference.
 - d) Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - e) Identify load conditions at time of inspection.
 - f) Provide photographs and thermogram of deficient area.
 - b. Test Parameters:
 - 1) Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 2°F at 86°F.
 - 2) Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 - 3) Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Refer to NFPA 70B, Section 20.17 (Infrared Inspection).
 - c. Test Results:
 - 1) Temperature differences of 2°F to 5 °F indicate possible deficiency and warrant investigation.

- 2) Temperature differences of 7°F to 27°F indicate deficiency; repair as time permits.
- 3) Temperature differences of 29°F and above indicate major deficiency; repair immediately.
- 4) Suggested actions based on temperature rise can be found in NETA Table 18.

B. Test Reports:

1. Testing firm shall do the following:
 - a. Prepare test report, including description of equipment tested, description of test, test results, conclusions and recommendations, retesting results, list of test equipment used and calibration date.
 - b. Show test results in comparison to industry and manufacturer's values and tolerances.
 - c. Interpret test results in writing and give recommendations for acceptance or rejection upon consultation with Owner's Representative and prior to energizing equipment.
 - d. Assure electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with contract documents.
 - e. Assure suitability of energization.
 - f. Report to the Owner's Representative any system, material, or workmanship that is found defective on the basis of acceptance tests.
 - g. Retest equipment when required.
 - h. Maintain written record of tests.
 - i. Utilize safety practices during the tests in accordance with:
 - 1) Acceptable state and local safety operating procedures
 - 2) Owner's safety practices
 - 3) OSHA
 - 4) NFPA 70E
 - j. Perform tests with apparatus de-energized and grounded, except where otherwise specifically required ungrounded by test procedures.
 - k. Assemble and certify final test report.
 - l. Provide 4 copies of complete test report.
 - m. Attach label to all tested equipment with indication of date tested and testing firm name.
2. Contractor shall do the following:
 - a. Investigate, replace, or repair any fault in material or in any part of the installation revealed by the tests.
 - b. Deliver one copy of each test report directly to Owner's Representative within 30 days after completion of testing, unless directed otherwise. Insert

a copy of each test report in the equipment operation and maintenance manuals.

C. Test Equipment:

1. Test Instrument Calibration:

- a. Testing firm shall have calibration program that assures test instruments are maintained with rated accuracy.
- b. Instruments shall be calibrated in accordance with the following frequency schedule:
 - 1) Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
 - 2) Laboratory instruments: 12 months
 - 3) Leased specialty equipment: 12 months where accuracy is guaranteed by lessor
- c. Dated calibration labels shall be visible on test equipment.
- d. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
- e. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
- f. Equipment used for field testing shall be more accurate than instrument being tested.
- g. Calibrating standard applied to testing equipment shall be of higher accuracy than instrument tested.

END OF SECTION 26 08 12

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SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 00 00 - General Electrical Requirements
- B. Section 26 50 00 - Lighting

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF SYSTEM

- A. Provide devices such as wall box dimmers, wall and ceiling mounted occupancy sensors, ambient light sensors, sensor power packs, etc., as shown on drawings.
- B. Openings shall be covered with devices and matching plates.
- C. Devices of same type shall be from same manufacturer.

1.4 REFERENCE STANDARDS

- A. UL20 - General Use Snap Switches.
- B. UL773A - Non-Industrial Photoelectric Switches for Lighting Control.
- C. UL924 - Emergency Lighting and Power Equipment
- D. NEMA WD 7 - Occupancy Motion Sensors.
- E. NEMA IP - Ingress Protection Rating
- F. California Building Energy Efficiency Standards
- G. California Title 20 Appliance Efficiency Database

1.5 SUBMITTALS

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

- B. Shop Drawings shall include:
 - 1. Bill of material
 - 2. Schematic diagrams
 - 3. Suggested manufacturer layouts of all devices including overlays of product range.
- C. Samples: One for each type of device and wall plate specified, in each color specified upon request.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations and type of devices.
 - 2. Operation and Maintenance Data:
 - a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
 - b. Include source and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

- A. Obtain devices from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

- B. Manufacturer shall provide standard 1-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers (Per campus standard):
 1. Wall Box Dimmers: Acuity nLight
 2. Low Voltage Switches: Acuity nLight
 3. Sensors and Power Packs: Acuity nLight
 4. Exterior Occupancy Sensors: Acuity nLight
 5. UL 924 Emergency Bypass/Control Device: Acuity nLight
 6. Exterior Photocells: Acuity nLight
 7. Self-Contained Automatic Timer Switches: Acuity nLight
 8. Line voltage devices when approved for use:
 - a. Ceiling mounted occupancy sensor: Legrand DT-355, or approved equal
 - b. Wall mount line voltage dimming: Legrand RH4FBL3PTC, or approved equal
 - c. Intermatic time clocks and photocell: to be approved by campus
- B. It is the responsibility of Electrical Contractor to ensure devices submitted meet or exceed functional intent and design quality standards.

2.2 FABRICATION AND MANUFACTURE

- A. Devices shall be UL listed for loads and voltages as indicated in contract drawings and specifications.
- B. Devices shall comply with CA Title 20 Appliance Efficiency Regulations.

2.3 WALL BOX DIMMERS

- A. Dimmers shall:
 1. Operate in ambient temperature range of 32°F to 104°F.
 2. Be linear slide or pushbutton preset or programmable dimmers with power-failure memory.
 3. Incorporate separate control of intensity and ON/OFF.
 4. Include voltage compensation circuitry that adjusts firing angle of dimmer to compensate light output for variations in AC line voltage. Dimmers in which firing angle is held constant with varying AC line voltage shall not be acceptable.
 5. Provide smooth and continuous IESNA Square Law Dimming Curve throughout entire dimming range.

6. Incorporate filter network to minimize interference (RFI) with radio, audio, and video equipment.
 7. Incorporate air-gap switch to meet requirements of UL 20 for air-gap switches in incandescent dimmers.
- B. LED dimmers shall:
1. Be approved for use with luminaire and driver.
 2. Provide smooth non-flicker dimming of controlled luminaires.
 3. Be 0-10V type, unless noted otherwise on drawings.
 4. Provide at least 10 steps for continuously dimmed luminaires.
 5. Refer to Section 26 50 00 - Interior Lighting for solid state dimming ballast/driver specification.

2.4 LOW-VOLTAGE SWITCHES

- A. Low voltage switches shall:
1. Mount in a single or double gang box.
 2. Be capable of multi-way switching.

2.5 OCCUPANCY AND VACANCY SENSORS

- A. Sensors shall:
1. Operate with all lamp and ballast combinations; including magnetic, hybrid, and solid- state ballasts/drivers.
 2. Operate with ultrasonic, microphonic, passive infrared or presence technologies as indicated on drawings.
 3. Have visible LED to indicate occupant detection.
 4. Have adjustable time delay with a maximum setting of 30 minutes and adjustable sensitivity.
 5. Contain isolated relay, or remote relay with normally open, normally closed, and common outputs for use with HVAC system, data logging, controlled receptacles or other system control options where indicated in the contract documents.
 6. Be provided with ceiling, wall or wall switch style mounting as indicated on drawings.
 7. Have daylight filter to ensure PIR sensor is insensitive to short-wavelength waves emitted by the sun.
 8. Incorporate by-pass switch to enable lighting to be turned on if sensor fails.
 9. Be low voltage wired in parallel to common power pack, where applicable
- B. Occupancy Sensor shall:
1. Provide automatic ON, automatic OFF operation where indicated on drawings.
- C. Vacancy Sensor shall:

1. Provide manual ON, automatic OFF operation where indicated on drawings.
- D. Partial-ON Occupancy Sensor shall:
1. Provide automatic ON for a portion of the luminaires within a space and automatic OFF for all luminaires within a space where indicated on drawings. The additional luminaires within a space will be controlled ON manually but will be forced OFF when occupancy is not detected.
- E. Partial-OFF Occupancy Sensor shall:
1. Provide manual ON, automatic OFF for a portion of the luminaires within an area where indicated on drawings.

2.6 AMBIENT LIGHT SENSORS

- A. Ambient light sensors shall:
1. Incorporate photoconductive cell to measure light levels between 1 and 1,000 footcandles.
 2. Be adjustable with deadband feature to prevent cycling of lighting from minor changes in cloud cover.
 3. Have adjustable time delay range from 3 to 5 minutes.
 4. Not permit lighting systems to be turned on if enough daylight is present.
 5. Incorporate by-pass switch to enable lighting to be turned on if sensor fails.

2.7 POWER PACKS

- A. Sensor power packs shall:
1. Be self-contained transformer relay modules.
 2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 3. Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads. Provide 24VDC output capable of controlling low-voltage occupancy sensors.

2.8 EXTERIOR OCCUPANCY SENSORS

- A. Exterior occupancy sensors shall:
1. Be a completely self-contained device capable of detecting presence in the controlled range by detecting changes between infrared energy in motion and the background space.
 2. Utilize passive infrared detection technology and a three level Fresnel lens to increase detection density and accuracy of motion detection.
 3. Be capable of mounting vertically or horizontally onto a standard outdoor junction box or integral to exterior luminaires.

4. Cover up to 35 ft with a field of view of 180 degrees or 52.5 ft with a field of view of 270 degrees.
5. Have an operating temperature range of -40°F to 130°F.
6. Be IP66 rated for outdoor applications.
7. Include a built-in light level sensor, adjustable by the user that will keep lights from turning on during daylight hours.
8. Have user-adjustable time delay settings, including an override ON option that enables controlled lights to be turned on remotely for the length of the time delay.
9. Be compatible with all electronic ballasts and LED drivers with no minimum load requirements.

2.9 UL 924 EMERGENCY BYPASS/CONTROL DEVICES

- A. UL 924 listed bypass relays shall:
1. Be UL924 listed and labeled for connection to both normal and emergency lighting power sources.
 2. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 3. Have normally closed dry contacts rated for switching 120-277 volts, 60 Hz. 20 amp loads.
 4. Have integral manual test switch.
 5. Have auxiliary isolated normally closed contact for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure.
 6. Have status indication for presence of normal and emergency power sources and current operational mode (normal or emergency).
 7. Utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.
 8. Be forced into the emergency mode upon loss of normal power sense and turn ON the emergency lighting.
 9. Automatically switch emergency lighting ON/OFF as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting ON regardless of the state of any external control device until normal power is restored.
- B. Operational temperature range shall be -40°F to 140°F.
- C. Device shall have universal mounting; surface, above suspended ceiling or recessed.

2.10 EXTERIOR PHOTOCELLS

- A. Photocells shall:
1. Have universal rated voltage inputs 120-277 VAC, 60 Hz.

2. Be rated for up to 2,000 watts.
 3. Have cadmium sulfide, 1" diameter cell.
 4. Have SPST normally closed contacts.
 5. Have a minimum delay of 3 minutes to prevent false switching.
- B. ON/OFF adjustment shall be done by moving light selector with range from 2 to 50 footcandles.
- C. Operational temperature range shall be -40°F to 140°F.
- D. Enclosure shall be die cast zinc, gasketed for maximum weatherproofing.
- E. Enclosure shall include positioning lug on top.
- F. Mounting shall be for 1/2" conduit nipple.

2.11 SELF-CONTAINED AUTOMATIC TIMER SWITCHES

- A. Timer switches shall:
1. Have universal rated voltage inputs 120-277 VAC, 60 Hz.
 2. Be programmable to turn lights OFF after a preset time.
 3. Have a ground wire and ground strap for safety with a latching air gap relay switching mechanism.
 4. Use Zero Crossing Circuitry to increase the relay life, protect from the effects of inrush current.
 5. Be compatible with all electronic ballasts, motor loads, LEDs and LED drivers, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed.
 6. Have no minimum load requirement and shall be capable of controlling 0 to 800 watt incandescent, fluorescent @ 100/120 VAC, 50/60 Hz; 0 to 1200 watts fluorescent @ 230/277 VAC, 50/60 Hz; 1/6 hp @ 125 VAC. LED with internal or external driver@ 100/120VAC.
 7. Have the option for light flash warning at five minutes before the timer runs out and again when the countdown reaches one minute.
 8. Have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.
 9. Have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
 10. Have a feature that shows the timer's countdown.
 11. Have the calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.
 12. Have a maximum allowed over-ride period no greater than 2 hours.

13. Be capable of operating as an ON/OFF switch.
14. Utilize terminal style wiring.
15. Have a 100% OFF override switch with no leakage current to the load.

2.12 FINISHES

- A. Color:
 1. Wall box dimmers, low-voltage switches, occupancy sensors, ambient light sensors and device cover plates: Per architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices at heights scheduled, and as indicated on drawings.
- B. Install wall devices vertically on latch side of door within 6" of frame edge, unless otherwise noted.
- C. Install ceiling devices as shown on drawings and as recommended by device manufacturer.
- D. Ceiling mounted occupancy sensors shall be located minimum of 6 ft from supply air diffusers.
- E. Install devices plumb, level with finished surfaces and free from blemishes.
- F. Verify device locations prior to rough in.
- G. Control wiring shall be low voltage, Class II wiring, electrically isolated from power wiring by a Class II transformer.
- H. Provide separate neutral conductor for each dimmer.
- I. Provide remote power pack and isolated relay outputs where wall switch style mounting is specified.
- J. Wiring shall be in conduit.
- K. Electrical Contractor shall be responsible for final adjustment and testing of all devices.
- L. All lighting control devices shall be installed and programmed by a certified California Advanced Lighting Control Training Program Installer.

- M. All line voltage controls shall be wired ahead of any room occupant controls so that lighting controls remain energized at all times.

3.2 TESTING

- A. Verify proper location and operation of all devices.
- B. Verify dimmers function without:
 - 1. Producing lamp flicker or audible noise.
 - 2. Interference of audio and visual equipment.
- C. Adjust occupancy sensors for a 15, UNO minute time delay.
- D. Adjust occupancy sensor sensitivity such that movement outside range of coverage shall not trigger sensor.
- E. Adjust ambient light sensor to maintain illuminance level equal to light level from controlled lighting in the space when no daylight is present or as indicated per drawings. Demonstrate ambient light sensor(s) control lighting as specified.
- F. The functionality of all installed lighting controls shall be verified by a certified California Advanced Lighting Control Training Program-Acceptance Test Technician as required in California Building Energy Efficiency Standards.

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SECTION 26 09 26 - LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 00 00 - General Electrical Requirements
- B. Section 26 05 33 - Surface Metallic Raceway System
- C. Section 26 09 23 - Lighting Control Devices
- D. Section 26 27 26 - Wiring Devices
- E. Section 26 51 00 - Interior Lighting
- F. Section 26 56 00 - Exterior Lighting

1.2 REFERENCE

- A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Provide a complete, functional, intelligent, low-voltage, networkable lighting control system consisting of, but not limited to, distributed relay modules, controllers, enclosures, occupancy sensors, photosensor daylight controls, switch stations, and auxiliary equipment for control of all types of lighting sources whether served from 120V or 277V, emergency or normal power.
- B. The lighting control system specified in this section shall provide time-based, sensor-based (both occupancy and daylight), and manual lighting control.
- C. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of "dimming lights to off."
- D. All system devices shall be networked together, enabling digital communication between devices.

- E. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity, even if network connectivity to the greater system is lost.
- F. The system architecture shall facilitate remote operation via a computer connection.
- G. The lighting control system shall interface with the projects building management system (BMS).

1.4 LIGHTING CONTROLS NARRATIVE

- A. Lighting Controls Concepts
 - 1. Digital room devices shall connect via free topology (daisy-chain, star or t-tap) to the distributed relay modules using CAT 5e cables with RJ-45 connectors to provide both data and power to room devices. Relay control modules and lighting control panels shall be capable of networking together and connect back to a network controller. Features of the local lighting control network include:
 - a. Automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the devices attached.
 - b. Replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
 - c. Button press configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- B. Lighting Control Strategies
 - 1. Astronomic Timeclock Scheduling: Clock shall automatically calculate sunrise and sunset times based on date and geographical positioning. Sunrise and sunset or selectable offset of up to 120 minutes may be used as activation times for any system timer.
 - 2. Timeclock Scheduling: Time of day events in public areas, and other spaces as indicated in drawings and schedules are keyed to project programming requirements. Programmable digital wall switches shall be provided with minimum of 24 available times (scheduled events) for use in developing time-of-day automated schedules. Timer shall have ability to turn relay outputs ON or OFF at standard times in 1-minute increments or at times calculated by astronomical clock for sunrise and sunset with offset. Timers shall be day-of-week selectable timers and may be programmed to activate on combination of

days of week (Sunday through Saturday), on days, or to activate on specific date only ("Holiday Schedule"). Non-holiday timer shall be capable of being programmed either to halt operation on holidays or to ignore holidays and continue normal operations on holidays.

- a. Blink Alert/Beep Warning: Programmable digital wall switches shall be set to blink prior to being turned OFF. Blink alert times shall be adjustable between 1 and 10 minutes in 1-minute increments. Relays programmed for blink alert function shall blink prior to turning OFF to warn occupants of upcoming OFF event. If ON command is received during blink alert time, relay output will be overridden and left ON for override time. Override times shall be adjustable from 1 to 6 hours in 1-hour increments.
3. Timer Switch: Digital countdown timer switch set to time-out after 2 hours with time scroll down if button is held used in single entrance electrical, mechanical and communication rooms as well as other storage rooms less than 50 square feet. Multi-entrance electrical and mechanical rooms will use programmable digital wall switches set to time-out after 2 hours.
 - a. Blink Alert/Beep Warning: Digital countdown timer switch or programmable digital wall switch shall be set to blink prior to being turned OFF. Blink alert times shall be adjustable between 1 and 10 minutes in 1-minute increments. Relays programmed for blink alert function shall blink prior to turning OFF to warn occupants of upcoming OFF event. If ON command is received during blink alert time, relay output will be overridden and left ON for override time. Override times shall be adjustable from 1 to 6 hours in 1-hour increments.
4. Vacancy/Occupancy Sensing: Enclosed spaces such as storage rooms, conference rooms, break rooms and private offices shall function as manual-on control spaces with vacancy sensor extinguishing lights after a 15 or 30-minute interval of no observed occupancy.
 - a. Occupancy Sensors for toilet rooms and stairwells shall operate as automatic-on control spaces with occupancy sensor extinguishing lights after a 15 or 30-minute interval of no observed occupancy.
5. Daylight Sensor Dimming: Light fixtures in perimeter daylight zones are governed in groups by photosensors determining real time daylight availability within primary daylight where applicable. Fluorescent and LED light fixtures are dimmed accordingly when daylight is present.
6. Preset Scene: Allows for programming preset scenes for flexibility, repeatability and fine tuning of light levels in various spaces.

1.5 REFERENCE STANDARDS

- A. ANSI/IEEE C62.41-1991 - Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

- B. ANSI/NFPA 70 - National Electrical Code
- C. ASTM D4674-02a - Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight
- D. IEC 801-2 - Electrostatic Discharge Testing Standard
- E. IEC/EN 60669-2-1 - Switches for household and similar fixed electrical installations - electronic switches
- F. ISO 9001:2000 - Quality Management Systems
- G. NEMA FCC - Emission Standards, Part 15
- H. UL 508 - Standard for Industrial Control Equipment
- I. UL 916 - Energy Management
- J. UL 924 - Emergency Lighting and Power Equipment
- K. UL 1472 - Solid-State Dimming Controls
- L. California Building Energy Efficiency Standards
- M. California Title 20 Appliance Efficiency Database

1.6 SUBMITTALS

- A. Submit under provisions of Division 01 and Division 26.
- B. Submittal package shall include, but not be limited to the following. Submittals that do not contain information listed below will not be considered for approval.
 - 1. Bill of materials consisting of detailed itemized listing of proposed equipment, including quantities and capacities for major system components.
 - 2. Product data sheets detailing major system components.
 - 3. Typical wiring diagrams for components interconnectivity per room type.
 - 4. Overall system schematic showing interconnection detail of each control with sufficient detail to indicate relative placement of major system components and labeled for the associated zones and spaces.
 - 5. Relay schedules indicating power source, scheduling and connected devices.
 - 6. Low-voltage switch schedule for multi-zone switches showing zones/scenes controlled.

7. Shop drawings that include name of project, quantity and physical dimensions of major system components, wire sizes and counts for required connections between system components.
8. Coordination plan drawings showing manufacturers suggested layout of all devices coordinated for ceiling types, lighting layouts, door swings.
9. Example Contractor Startup/Commissioning Worksheet - must be completed prior to factory start-up.
10. Hardware and Software Operation Manuals.
11. Other operational descriptions as necessary.

1.7 QUALITY ASSURANCE

- A. Factory Assembly: Relays, contactors, controllers, enclosures, occupancy sensors, photosensor daylight controls switch stations and miscellaneous components shall be factory assembled and tested. System components shall arrive at job site completely prewired and ready for installation, requiring only connection of lighting circuits and low-voltage control stations and/or network terminations. Connections shall be made to clearly and permanently labeled termination points. Systems that require field assembly shall not be acceptable.
- B. Component Testing: System components and assemblies shall be individually tested prior to assembly. Once assembled, finished products shall be tested for proper operation of control functions per specifications prior to shipment.
- C. Provide system software, hardware and equipment that is designed, tested, manufactured and warranted by a single manufacturer.
- D. NEC Compliance: System components shall comply with applicable sections of National Electrical Code (NEC) as required.
- E. NEMA Compliance: System components shall comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosure.
- F. UL Approval: Applicable equipment shall be UL listed under section 916/508 and shall bear labels indicating compliance.
- G. FCC Emissions: Applicable equipment shall comply with FCC emissions standards specified in Part 15, Subpart J for Class A applications.
- H. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in- house engineering for product design activities.
- I. Lighting control system components:

- J. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

1.8 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
- B. Ambient temperature: 32° to 104° F (0° to 40° C).
- C. Relative humidity: maximum 90 percent, non-condensing.
- D. Lighting control system shall be protected from dust and debris during installation.

1.9 RECORD DOCUMENTS

- A. After system installation and testing, submit record documents under provisions of Division 01 and Division 26.
- B. Accurately record location of switches, power supplies and control enclosures. Include description of switching and circuiting arrangements.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. After system installation and testing, submit operation and maintenance manuals under provisions of Division 01 and Division 26.
- B. Include replacement part numbers.

1.11 WARRANTY

- A. Contractor shall warranty completed lighting control system wiring and equipment to be free from inherent mechanical and electrical defects for period of (5) five years from date of substantial completion.
- B. Warranty service for equipment shall be provided by system supplier's factory-trained representative during normal working hours, Monday through Friday, excluding holidays. Warranty shall include parts, labor, and necessary travel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acuity nLight (Campus Standard - No Substitutions)

2.2 ROOM CONTROLLERS/RELAY MODULES

- A. Room Controllers shall be provided to match the room lighting load and control requirements. All room controllers shall be capable of connecting to a networked lighting control system. The control units shall include the following features:
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Default automatic configuration capabilities, allowing a room controller to be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 4. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 5. Plenum rated
 6. Manual override and LED indication for each load
 7. Dual voltage (120/277 VAC, 60 Hz)
 8. Zero cross circuitry for each load.
- B. Class 2 Lighting Control Relays
1. Provide quantities of Class 2 lighting control relays as indicated on drawings and schedules and as specified herein.
 2. Class 2 lighting control relays shall be individually UL and CUL listed and shall bear labels indicating compliance.
 3. Class 2 lighting control relays shall be designed for control of 120 or 277 VAC lighting control circuits at full 20 amps.
 4. Each Class 2 lighting control relay shall contain necessary equipment to provide status monitoring and pilot light activation.
 5. Control relays shall have 14,000 Amp SCCR.
- C. On/Off Room Controllers shall include:
1. Multiple relay configurations
 2. Efficient 150 mA switching power supply
 3. Minimum of three RJ-45 DLM local network ports
- D. On/Off/Dimming Room Controllers shall include:
1. Real time current monitoring
 2. Multiple relay configurations
 3. Efficient 250 mA switching power supply
 4. Minimum of four RJ-45 DLM local network ports.

5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
6. Optional Network Bridge for BACnet MS/TP communications.
7. The following dimming attributes shall be selectable using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - c. Set lamp burn in time for each load up to 100 hours

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- A. Wall or ceiling mounted passive infrared (PIR), ultrasonic (UT) or dual technology (DT) (passive infrared and ultrasonic) occupancy sensor as indicated on plans. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
- B. Digital Occupancy Sensors shall provide display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton programming for the following variables:
 - a. Sensitivity - 0-100% in 10% increments
 - b. Time delay - 1-30 minutes in 1-minute increments
 - c. Test mode - Five second time delay
 - d. Detection technology - PIR, Ultrasonic or Dual Technology activation and/or re- activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the lighting control local network.
 2. One or two RJ-45 port(s) for connection to lighting control local network.
 3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool.
 4. Device Status LEDs including:
 - a. PIR Detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 6. Manual override of controlled loads.
- C. Multiple occupancy sensors may be installed in a room using the free topology lighting control local network.

2.4 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configurations; compatible with wall plates with decorator opening. Wall switches shall include the following features:
1. Two-way infrared (IR) transceiver for use with configuration remote controls.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Red configuration LED on each switch that blinks to indicate data transmission.
 4. Blue Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- B. The following switch attributes shall be available for selection using a wireless configuration tool:
1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 2. Individual button function may be configured to Toggle, On only or Off only.
 3. Individual scenes may be locked to prevent unauthorized change.
 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 5. Ramp rate may be adjusted for each dimmer switch.
 6. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
- C. Switch Plates and Control Stations
1. Provide switch plates and switches of quantities and type shown on drawings and specified herein.
 2. Switch plates shall consist of control panel faceplate, switches, LED pilot lights and mounting hardware.
 3. Switch plates shall be finished as specified in Section 26 27 26 - Wiring Devices.
 4. Switch plates shall be designed to mount to standard electrical gang boxes for either flush or surface mounting.
 5. Switch plate labeling and switch identification shall be accomplished through use of engraved phenolic labels, permanently attached to switch plate or engraved into control panel faceplate material. Silk-screening or painted labeling shall not be acceptable.

6. Provide with custom engraving with appropriate button, zone and scene engraving descriptions. Contractor to provide engraving schedule to Owner's Representative prior to release for fabrication. Refer to Electrical Lighting Switch Schedule E-011 thru E-017.
 7. Switch plates shall be supplied with appropriate number of momentary pushbutton type switches as indicated on drawings.
 8. Switches shall be momentary pushbutton type with pilot light.
- D. Two RJ-45 ports for connection to lighting control local network.
- E. Multiple digital wall switches shall be installed in a room by connecting them to the free topology local lighting control network.

2.5 DIGITAL PHOTOSENSORS

- A. Digital photosensors shall work with room controllers to provide automatic switching or dimming for any load type connected to a room controller. Closed loop photosensors shall measure the ambient light in the space and control a single lighting zone. Open loop photosensors shall measure incoming daylight in the space and be capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.
- B. Digital photosensors shall include the following features:
1. An internal photodiode that measures only within the visible spectrum and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-10,000 footcandles (fc).
 3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling after they turn off.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
 6. The capability for wall-switch to override sensor, allowing occupants to reduce lighting level or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
 7. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool.

8. Red configuration LED that blinks to indicate data transmission.
 9. Blue status LED indicates test mode, override mode and load binding.
 10. Recessed switch to turn controlled load(s) ON and OFF.
 11. One RJ-45 port for connection to local lighting control network.
 12. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor shall be capable of being mounted on a ceiling tile, skylight light well, suspended light fixture or backbox.
- C. Closed loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
 2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
 3. Automatically establishes setpoints following self-calibration.
 4. A sliding setpoint control algorithm for dimming daylight harvesting with a "Day Setpoint" and the "Night Setpoint" to prevent the lights from cycling.
- D. Open loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 60-degree angle cutting off the unwanted light from the interior of the room.
 2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
 3. A proportional control algorithm for dimming daylight harvesting with a "Setpoint" to be maintained during operation.

2.6 CONFIGURATIONS TOOLS

- A. A wireless configuration tool shall be provided to facilitate customization of local lighting control networks and set up of open loop daylighting sensors. The configuration tool will communicate to control devices using infrared, while PC software is connected to the local network via USB interface.
- B. Features and functionality of the wireless configuration tool shall include:
1. Two-way infrared (IR) communication with lighting control IR-enabled devices within a range of approximately 30 feet.
 2. High visibility display, pushbutton user interface and menu-driven operation.
 3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
 4. Save up to nine occupancy-sensor setting profiles, and apply profiles to selected sensors.
 5. Temporarily adjust light level of any load(s) on the local network and incorporate those levels in scene setting.

6. Adjust or fine-tune daylighting settings established during auto-commissioning and input light level data to complete commissioning of open loop daylighting controls.

2.7 NETWORK BRIDGE

- A. The network bridge connects a local lighting control network to a BACnet-compliant network for communication between rooms, panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication.
 1. The network bridge may be incorporated directly into the room controller hardware or be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Provide operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
 3. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control features as provided by the digital lighting control room devices on each local network. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after-hours schedule state for the room
 - b. Read the detection state of the occupancy sensor
 - c. Read/write the On/Off state of loads
 - d. Read/write the dimmed light level of loads
 - e. Read the button states of switches
 - f. Read total current in amps, and total power in watts through the room controller
 - g. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - h. Activate a preset scene for the room
 - i. Read/write daylight sensor fade time and day and night setpoints
 - j. Read the current light level, in footcandles, from interior and exterior photosensors and photocells
 - k. Set daylight sensor operating mode
 - l. Read/write wall switch lock status

2.8 NETWORK CONTROLLER

- A. The Digital Lighting Control System shall include at least one network controller to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser. Each network controller shall have support for

one, two or three networks as required and allow for control of a maximum of 127 local networks (rooms) and/or lighting control panels per segment network.

- B. Operational features of the Network Controller shall include the following:
1. Connection to PC or LAN via standard Ethernet TCP/IP.
 2. Graphical user interface, compatible with Internet Explorer 8, or equal browser.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Automatic discovery of all digital lighting control devices on the segment network(s).
 5. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 6. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after-hours operation.
 7. Ability to set up schedules for rooms and control panels. Schedules shall automatically set controlled zones or areas to either normal hours or after hours mode of operation.
 8. Ability to group rooms and loads for common control by schedules, switches or network commands.
 9. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.
 10. Provide seamless integration with the BAS via BACnet IP
- C. Networking
1. Individual lighting controllers shall be capable of being connected together and programmed on single network cable. Network cable shall consist of shielded single twisted pair.
 2. Once connected together, entire control system shall be accessible from single point where system user may program, monitor and control any control device on network. Switch input on network shall be able to control relay outputs on network without limitation.
 3. Programming: Programmable controllers shall be capable of being programmed, monitored or controlled through below methods, either individually or simultaneously. Regardless of method being used to program, monitor or control, programmable controller must remain completely functional during this process. Controllers that must be taken "OFF LINE" for programming are not acceptable. Programming changes shall take effect immediately as they are programmed.

4. Diagnostic Aids: Programmable lighting controllers shall indicate main power supply is present and operational via LED pilot. Relay output shall have visual indication of on/off status. System users shall be able to view current status of relay outputs, force relay output ON or OFF, and view current status of switch inputs.
5. Data Protection and Storage: Programmed data shall be stored in system that is protected from memory loss. Stored program data shall be protected from loss during power outage without power of any type for minimum period of 2 years.
6. Power Failure and Power-Up Options: Programmable lighting controllers shall automatically shut down whenever incoming power fails to be delivered to controller within required limits. When power is returned to controller, one of the following (user selectable) power-up modes will be implemented for each controlled relay output in system:
 - a. No Action: Upon restoration of incoming control power, controller electronics shall be restarted and resume normal operations, and circuits will be maintained in condition they were last in.
 - b. Exception: Time-scheduled events that were to take place during power outage will be automatically activated to bring controller into correct operating status.
 - c. ON: Upon restoration of incoming control power, controller electronics shall be restarted, and circuits shall be turned on.
 - d. OFF: Upon restoration of incoming control power, controller electronics shall be restarted, and circuits shall be turned off.
7. True Relay Status Feedback: Controller shall be provided with circuitry to monitor actual current status of each relay.
8. Staggered or Instant Relay ON/OFF Activation: Programmable lighting controller shall be provided with jumper to enable user selectable instant or staggered relay operation. In instant mode, relays in controller will be turned ON or OFF at same time. In staggered mode, relays will be turned ON or OFF with 20-msec pause between each relay being switched.
9. Input to Output Programmability: Switch input in control network may be programmed to control relay output(s) on network, without limitation.

2.9 EMERGENCY LIGHTING

- A. Provide Emergency Lighting Control Unit - UL 924 listed bypass relay device to monitor a switched circuit providing normal lighting to an area. The unit shall allow for normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 1. Allow control of emergency lighting fixtures in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full

- brightness upon loss of normal power supplying the control device. Emergency lighting operation shall be independent for each controlled area and shall not require a generalized power failure for proper operation.
2. Have normally closed dry contacts capable of switching 120/277 volts, 50/60 Hz., 20 amp ballast load rating
 3. Have universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.
 4. Integral push to test button. Pressing and holding this button shall instantly force the unit into emergency mode and turn on emergency lighting. Releasing the test button shall immediately return the unit to normal operation.
 5. Auxiliary contact with dedicated leads and 24 VDC source for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure. Breaking contact between the terminals shall force and hold the emergency lighting on until the terminals are again closed. An integral LED indicator shall indicate the unit's current remote activation status.
 6. The device shall provide separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit's current operational mode (normal or emergency).
 7. The device's normal power input lead shall be connected to the line side of the control device such that any upstream fault causing a loss of power, including the tripping of the branch circuit breaker, will force the unit into the emergency mode and turn on the emergency lighting.
 8. The unit shall automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
 9. The unit shall utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.
 10. The unit shall be UL and cUL listed and labeled for connection to both normal and emergency lighting power sources.
 11. The unit shall have a 5-year warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions are as shown on Drawings.

- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

- A. Install equipment as indicated on Drawings and in accordance with manufacturer's written instructions and recognized industry practices.
- B. Use minimum 18 AWG copper conductor building wire or manufacturer's standard suggested wiring size, whichever is larger, in conduit for low voltage wiring.
- C. Provide equipment at locations and in quantities indicated on drawings. Provide any additional equipment required to provide control intent.
- D. Confirm final engraving schedule with electrical engineer prior to release for production.
- E. Energize all fluorescent lamps with dimming controls for a required burn in period of 100 continuous hours.
- F. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.

3.3 COMMISSIONING

- A. System commissioning and startup shall be done by factory-certified field service representative during site visits to ensure proper system installation and operation under the following parameters:
 - 1. Qualifications for factory-certified field service engineer:
 - a. Minimum experience of 2 years training in the electrical/electronic field.
 - b. Certified by the equipment manufacturer on the system installed.
 - 2. Make a site visit upon completion of installation of Architectural Lighting Control Systems to:
 - a. Verify connection of power feeds and load circuits.
 - b. Verify connection and location of controls.
 - c. Energize processor panel and download system data program.
 - d. Verify proper connection of panel links (low voltage/data) and address panel.
 - e. Verify system operation control by control, circuit by circuit.
 - f. Verify proper operation of manufacturers interfacing equipment.

- g. Verify proper operation of manufacturers supplied PC and installed programs.
 - h. Verify operation of PC modem and test dial-up access.
 - i. Verify control station setup.
 - j. Verify control station zone intent.
 - k. Verify occupancy sensor timeout and sensitivity calibration.
 - l. Calibrate Daylight Harvesting sensors and verify functionality.
 - m. Verify proper functionality and set up of all ancillary input devices and equipment.
 - n. Verify Graphical software control programming.
 - o. Obtain sign-off on system functions.
- B. Following installation completion and basic system setup, contractor shall provide a qualified, fully trained, system programmer to field program system functionality. Programmer shall meet with Owner's Representative and Owner's Representative to determine desired sequence of operation. System programming shall be stored on USB flash drive and programming shall be multi level password protected. Programming will include:
- 1. Setting preset lighting levels for all areas.
 - 2. Setting time of day Time Clock events.
 - 3. Setting Astronomic Time Clock events.
 - 4. All other items required for full system functionality per design intent.

3.4 TESTING

- A. Tested by a Title-24 certified advanced lighting control acceptance tester.
- B. Check dimmer preset control for proper operation.
- C. Verify dimmers function without producing lamp flicker or audible noise.
- D. Verify dimmers function without interference of audio and visual equipment.
- E. Verify ambient light sensor to maintain illuminance level equal to light level from controlled lighting in the space when no daylight is present or as indicated per drawings. Demonstrate ambient light sensor(s) control lighting as specified.
- F. Verify occupancy sensors for proper time delay.
- G. Verify proper operation of occupancy sensor switches and by-pass switches.
- H. Verify occupancy sensor sensitivity such that movement outside range of coverage shall not trigger sensor.

- I. Verify system is functioning in accordance with the lighting plans, diagrams, sequences, details and specifications.
- J. Check the BAS relay interface for the occupancy annunciation of each room.
- K. Verify integration of multi-scene dimmers with the AV system.
- L. The functionality of all installed lighting controls shall be verified by a certified California Advanced Lighting Control Training Program-Acceptance Test Technician as required in 2016 California Building Energy Efficiency Standards.

3.5 TRAINING

- A. Contractor shall provide, as part of this contract, minimum of 16-hours of system operation training for Owner. Training shall be at time to be stipulated by Owner's Representative and shall include system capabilities, operation, maintenance, programming and troubleshooting. Training and programming shall be completed prior to job closeout.
- B. Provide post-occupancy training and commissioning session to allow for modifications to system programming. Session to be coordinated with facilities personal 90 days after building occupancy.

3.6 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 26 00 00.
- B. Demonstrate proper operation of system.
- C. Upon completion of installation and after circuits have been energized, demonstrate capability and compliance of system with specified requirements.
- D. Refer to Electrical Drawings for relay schedules and system riser diagrams.
- E. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)

END OF SECTION 26 09 26

SECTION 26 10 00 - MEDIUM-VOLTAGE ELECTRICAL DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 13.16 - Medium-Voltage Cable
- B. Section 26 05 33 - Raceways and Boxes for Electrical Systems
- C. Section 26 05 43 - Underground Ducts and Raceways for Electrical Systems
- D. Section 26 05 73 - Power System Studies
- E. Section 26 08 12 - Power Distribution Acceptance Tests
- F. Section 26 08 13 - Power Distribution Acceptance Test Forms
- G. Section 26 12 19 - Pad-Mounted, Liquid-Filled, Medium-Voltage Transformers
- H. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 QUALIFICATIONS FOR MEDIUM VOLTAGE ELECTRICAL WORK

- A. In addition to a C10 electrical contractor's license the qualified installer will have the following:
 - 1. All employees of the C-10 electrical contractor will hold a valid "State Certified General Electrician" card issues by the California Department of Industrial Relations' Division of Apprenticeship Standards.
 - 2. Person(s) performing medium voltage terminations will possess a certification indicating that they have attended formal training on splicing and terminating medium voltage cables in the types of terminations being performed. Successful completion of the course and examination will be provided to the University prior to the start of any work.
 - 3. Person(s) performing medium voltage work or installation will have at least 5 years of verifiable experience performing such work. Submit a record of employment or projects for the University to review and approve.

3.2 ACCEPTANCE TESTING FOR MEDIUM VOLTAGE WORK

- A. The installing contractor will retain the services of a 3rd party testing firm to perform acceptance tests on all medium voltage equipment and cables. The 3rd part testing firm's qualifications will be submitted to the University with samples of the test forms that are scheduled for use before testing takes place. The University must approve in writing of the 3rd party testing firms qualifications prior to performing testing.
- B. The University will be present in the field for all tests, inspections and times at which equipment is first placed into service. Notify University Representative 10 working days prior to performing any tests.
- C. All equipment will be placed in its final installation location and fastened securely before acceptance testing is to take place. Acceptance test performed prior to equipment installed in its final installation location will not be considered or accepted.
- D. All cable test will be performed after cable installation is fully complete with the exceptions of termination make up. All manhole cable racking, arc proofing, duct sealing, etc. will be completed before cable is to be acceptance tested.
- E. All cable tests will be performed within 12 hours of their planned energization time. Cable test performed longer than 12 hours before energization will require a retest at the contractor's expense as test over 12 hours old will not be considered. The University will not accept cable that has been tested more than 2 separate times and recommends that the contractor sequence work appropriately so that multiple cable tests are not required as testing stresses cable.

3.3 DISTRIBUTION STANDARDS:

- A. Medium voltage underground system conductors will be installed in Schedule 40 conduit. At any location that the conduit must transition above grade (such as at a pole riser) that transition will be constructed in rigid steel to a point of 15 feet above grade.
- B. Medium voltage underground conduits will be 5" and include 1 spare for each installed feeder.
- C. Medium voltage underground conduits will be encased in red concrete with a minimum of 5 sack mix. The encasement shall be 6 inches from the edge of the encasement to any part of the conduit on the top and 2 sides of the conduit and 3 inches on the bottom of the conduit.
- D. Overhead distribution construction will only be permitted to be used as an acceptable method of distribution construction by the Director of Facility Planning and Capital Projects.

- E. Overhead distribution facilities will be constructed per the current PG&E standards including phase separation compliant with current California Wildlife and Raptor Compliance.
- F. Provide shop drawings detailing the proposed pole framing on each type of framing scenario that is to be used in the project. Submit to University for approval prior to commencing work.

3.4 EQUIPMENT FOR MEDIUM VOLTAGE WORK

- A. Provide submittals for each piece of the medium voltage installation for the University to review and approve. Submitted items include but are not limited to: Transformers, Vaults, Cables, Conduit, Ground Wire and Fittings, Secondary Wire, Medium Voltage Terminations, Low voltage Terminations, Sectionalizing Switches, Load Interrupters, Cable Accessories, Circuit Breakers and Fuses.

3.5 SPLICES

- A. Splices in the medium voltage network must be shown on the drawings or approved by the University in advance.
- B. No splices will be permitted in manholes or other structures below grade.
- C. Splices will be performed in above grade junction cabinets using separable connectors.
- D. Overhead cable splices will take place at poletop dead-end locations only. Tensioned splices will not be accepted.

3.6 MEDIUM VOLTAGE DISTRIBUTION CABLES:

- A. All cable will be 15 KV rated Type MV-105 220mils 133% EPR copper tape shielded cable.
- B. All medium voltage cables will be fire taped in all manholes, switches and transformers from the point of conduit entry to the cable termination.
- C. Cable installed in manholes and vaults will have sufficient slack to go once around the perimeter of the vault + 5 feet. Cable will be racked and fire taped.

3.7 UNIT SUBSTATIONS:

- A. All unit substations (transformers) will be pad mounted, oil filled units located outdoors adjacent to the building being served.

- B. All transformers will be provided with loop feed bushings with the corresponding switches to allow feeds A, B and transformer primary to be switched independently of each other.
- C. All transformers will be provided with oil immersed fusing on the primary input of the transformer.
- D. All transformers will be provided with 1 spare set of fuses attached to the primary compartment door.
- E. All transformers will be mounted on a transformer utility vault. This vault will have a manhole lid located at the front of the transformer doors and be an open bottom type vault installed on a minimum of 18' of crushed granite.
- F. Provide a sump pump connected to the building power via an emergency circuit (if available) and the storm drain.
- G. Primary and secondary conduits will be terminated in this vault and route to their appropriate switch or building main service gear.
- H. Under no circumstances will dry type unit substations or transformers be permitted.
- I. Acceptance test all medium voltage transformers per the current NETA ATS by a 3rd party testing firm that has been pre-approved by the university
- J. Provide a starting DGA analysis of the transformer oil after the transformer has been energized and loaded for a period not less than 1 week. All dissolved gas levels shall be at "condition 1" per the IEEE standards for DGA analysis.

3.8 MEDIUM VOLTAGE CIRCUIT PROTECTION:

- A. Submit qualifications of the Registered Professional Electrical Engineering firm to perform the coordination study. Firms must have at least (5) years of experience performing coordination studies on medium voltage equipment.
- B. A coordination study shall be performed on all new medium voltage equipment being installed to maintain established selectivity using IEEE standards.
- C. Submit coordination study to the University Representative for review and approval.
- D. Upon University approval 3rd party testing firm will implement recommended coordination study settings and test equipment for compliance to the recommended settings.

3.9 MEDIUM VOLTAGE CIRCUIT PROTECTION:

- A. Submit qualifications of the Registered Professional Electrical Engineering firm to perform the coordination study. Firms must have at least (5) years of experience performing coordination studies on medium voltage equipment.
- B. A coordination study shall be performed on all new medium voltage equipment being installed to maintain established selectivity using IEEE standards.
- C. Submit coordination study to the University Representative for review and approval.
- D. Upon University approval 3rd party testing firm will implement recommended coordination study settings and test equipment for compliance to the recommended settings.

END OF SECTION 26 10 00

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SECTION 26 12 19 - PAD MOUNT, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 00 00 - General Electrical Requirements
- B. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- C. Section 26 05 53 - Electrical Systems Identification
- D. Section 26 08 12 - Power Distribution Acceptance Tests
- E. Section 26 08 13 - Power Distribution Acceptance Test Tables

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF SYSTEM

- A. Specification covers 3-phase, liquid-filled, compartmental type, pad-mounted transformers, including tap changers, fuses, and terminations.

1.4 REFERENCE STANDARDS

- A. ANSI C57.12.22 - Standard for Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, 3- Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA and Smaller: High Voltage, 34,500Grd/19,920 V and Below; Low-Voltage, 480 V and Below - Requirements.
- B. ANSI C57.12.26 - Standard for Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, 3- Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, H-V, 34,500 Grd/19,920 V and below; 2500 kVA and Smaller.
- C. ANSI C57.12.28 - Pad-Mounted Equipment - Enclosure Integrity.
- D. IEEE C57.12.00 - Standard General; Requirements for Liquid - Immersed Distribution, Power, and Regulating Transformers.

- E. UL 340 - Tests for Comparative Flammability of Liquids.
- F. 10 CFR 431.196 (b) (2) - Energy Conservation Standards and Their Effective Dates

1.5 SUBMITTALS

- A. Submit shop drawings for equipment provided under this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: ABB, Cooper, General Electric, RTE, Square D or equal
- B. Rating of transformer(s) shall be as shown on drawings:
 - 1. kVA as shown on plans
 - 2. Primary Voltage as shown on plans
 - 3. BIL 95 kV
 - 4. Secondary Voltage As required by the project.
 - 5. Impedance As required by the project.
 - 6. Transformers shall be dual rated 55/65 degree C

2.2 CONSTRUCTION

- A. Transformer(s) shall:
 - 1. Be compartmental type, self-cooled, tamper-resistant and weatherproof.
 - 2. Include sealed tank construction to withstand pressure of 15 psi.
 - 3. Include welded cover.
 - 4. Tank, enclosure, termination compartment and all related parts and fasteners to be stainless steel.
- B. Transformer tank and high and low voltage compartments shall be assembled as integral unit.
- C. High and low voltage compartments shall be located side by side, separated by a stainless steel barrier.
- D. Cooling panels will be provided on back of tank.
- E. High voltage compartment shall not be accessible until low voltage door has been opened.
- F. Low voltage door shall have 3-point latching mechanism with vault type handle having provisions for single padlock.

- G. Provide lifting eyes and jacking pads.
- H. Include tank grounding provisions in each compartment.
- I. Penta bolt hardware for door closure is required in addition to padlocking provisions

2.3 FINISH

- A. In accordance with ANSI C57.12.28 - Standard for Pad-mounted Enclosure Integrity.

2.4 INSULATING FLUID

- A. Coolant and insulating fluid shall be less flammable, dielectric, with fire point of not less than 300°C Liquid shall be biodegradable and nontoxic, Envirotemp FR3.

2.5 CORE AND COIL CONSTRUCTION

- A. Coils shall be wound with copper windings.
- B. Core shall be high grade, grain oriented silicon steel laminations.
- C. Core and coil assemblies shall be stacked core type, 3-legged construction.
- D. Internal leads shall be insulated.
- E. Manual Tap Changer:
 - 1. Provide tap changer, externally operated.
 - 2. Tap changer handle shall have provisions for padlocking.
 - 3. Tap changer shall be 5-position with four 2-1/2% full capacity taps, 2 above and 2 below rated voltage and 1 at nominal.

2.6 HIGH VOLTAGE COMPARTMENT

- A. Terminations:
 - 1. Terminations shall be dead front construction.
 - 2. Transformer to be loop feed with (3) 2 position switches. Provide bushing well inserts and insulated caps for unused loop feed.
 - 3. Bushing wells shall be externally clamped and externally removable.
 - 4. Provide 1 set of load break bushings and 1 load break feed-thru insert for each phase.
 - 5. Mount lightning arrestors to one side and phase conductor elbows to other side.
 - 6. Provide surge arrestors as shown on the plans and specifications.
- B. High Voltage Switch:

1. Provide load break, gang operated, oil immersed switch, with eye for hot stick operation.
 2. Switch shall be 2-position OFF-ON.
 3. Switch shall be stacked deck, spring loaded cam, rotary operated.
- C. High Voltage Fusing:
1. Fuses shall have continuous current ratings sized per manufacturer's recommendations for indicated kVA, impedance, and primary voltage.
 2. Current limiting fuses shall be sized for sufficient duty for installation on the campus system.
- D. Provide pentahead enclosure security.

2.7 LOW VOLTAGE TERMINATIONS AND EQUIPMENT

- A. Bushings shall be molded epoxy.
- B. Externally clamped, blade type spade terminals with 6 hole NEMA spacing.
- C. Low voltage neutral bushing shall be fully insulated.
1. Connect to adjacent ground pad on tank with detachable strap.
- D. Accessories:
1. Each transformer shall be equipped with the following:
 - a. Dial type thermometer for indicating top liquid temperature.
 - b. Globe valve to serve as drain valve, bottom filler plug connection, and liquid sampling valve.
 - c. Globe valve for top filter plug connection and vacuum pump connection.
 - d. Pressure vacuum gauge.
 - e. Magnetic liquid-level indicator.
 - f. Spare fuse pocket with 1 complete set of fuses.
 2. Pressure relief device.
 3. Stainless steel nameplate mounted in low-voltage compartment with the following information:
 - a. Serial number and style number.
 - b. Graphic representation of high-voltage and low-voltage connections.
 - c. kVA ratings at all cooling class ratings and temperature rises.
 - d. Transformer impedance at 55°C base kVA rating.
 - e. Tap changer positions, voltages and full load currents at each tap setting.
 - f. Low voltage rating and full load current.
 - g. Gallons of liquid in tank and radiators.
 - h. Maximum allowable pressure on tank.
 - i. Transformer weight with and without oil.

- j. Listing as non-PCB transformer.
- E. Labeling:
 - 1. Provide warning label on outside high voltage compartment door and danger label on inside low voltage compartment door.

2.8 HARDWARE

- A. Provide hardware, including bolts, fasteners, caps, plugs, etc. of corrosion resistant materials or plated with corrosion resistant materials.

2.9 TESTING

- A. Report of transformer tests shall be submitted for each transformer:
- B. Complete all tests for liquid filled transformers noted in spec section 26 08 12.
 - 1. Standard ANSI tests.
 - 2. Resistance measurements of windings on rated voltage tap of each transformer and at tap extremes of 1 transformer only of given rating on order.
 - 3. Ratio tests on rated voltage connections and on tap connections.
 - 4. Phase-relation and polarity tests on rated voltage connections.
 - 5. No load losses and excitation current at rated voltage on rated voltage connections.
 - 6. Impedance and load losses at rated current on rated voltage connections of each transformer and on extremes of 1 unit only of given rating on order.
 - 7. Applied and induced potential tests.
 - 8. Regulation and efficiency at rated load and voltage.
 - 9. Insulation resistance tests (high voltage to ground, low voltage to ground, high voltage to low voltage).
- C. Temperature test or tests shall be made on 1 unit only of transformers covered by these specifications of given rating, provided that test data is not available from records of temperature tests on duplicate or essentially duplicate transformer. Tests are to be completed in the field after the transformer has been installed in its final installed location.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components as indicated and in accordance with manufacturer's instructions and recommendations.

- B. Mechanical lugs not permitted for secondary wire connection. Install compression lugs appropriate for wire size used.
- C. Install transformer level and plumb.
- D. Provide means for lifting complete transformer.
- E. Bearing surfaces of lifting means shall be free from sharp edges.
- F. Provide lifting means for untanking transformer.
- G. Base shall permit rolling (or sliding) in directions of both center lines of transformer and provision shall be made for pulling transformer in these directions.
- H. Locate jacking facilities near extreme ends of junction of base segments.
- I. Jack ports or lugs shall be so designed that lifting members of jack can be inserted.
- J. If liquid filling of any part of transformer is required at job site, supplier shall furnish liquid and job site supervision, and shall furnish or make available suitable filter press and vacuum pump.

3.2 ACCEPTANCE TESTING

- A. Testing by Testing Agency
- B. Acceptance testing to be performed in accordance with Section 26 08 12 - Power Distribution Acceptance Tests.

END OF SECTION 26 12 19

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- E. Section 26 05 53 - Electrical Systems Identification
- F. Section 26 05 73 - Power System Studies
- G. Section 26 08 12 - Power Distribution Acceptance Tests
- H. Section 26 27 13 - Electrical Metering
- I. Section 26 28 13 - Fuses
- J. Section 26 43 00 - Surge Protective Devices

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes free-standing, dead-front type low-voltage distribution switchboards.

1.4 REFERENCE STANDARDS

- A. ANSI/IEEE C37.13 - Low-Voltage AC Power Circuit Breakers Used in Enclosures
- B. ANSI/NECA 400 - Recommended Practice for Installing and Maintaining Switchboards
- C. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits

- D. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- E. NFPA 70 - National Electrical Code
- F. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- G. NEMA AB 3 - Molded-Case Circuit Breakers and Their Applications
- H. NEMA FU 1 - Low-Voltage Cartridge Fuses
- I. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- J. NEMA PB 2 - Dead-Front Distribution Switchboards
- K. NEMA PB 2.1 - General Instructions for Proper Handling, Installation and Maintenance of Dead- Front Distribution Switchboards Rated 600 Volts or Less
- L. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- M. UL 98 - Enclosed and Dead-Front Switches
- N. UL 486A-486B - Wire Connectors
- O. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- P. UL 869A - Reference Standard for Service Equipment
- Q. UL 891 - Dead-Front Switchboards
- R. UL 1053 - Ground-Fault Sensing and Relaying Equipment
- S. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.5 SUBMITTALS

- A. Product Data: For each switchboard, components and accessories indicated:
 - 1. Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of surge protective devices, switching and overcurrent protective devices.
 - 2. Features, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.

- B. Shop Drawings:
 - 1. For each switchboard specified in this Section:
 - a. General Arrangement:
 - 1) Indicate front, plan, and side views of switchboards; access requirements (front, side, rear); overall dimensions and components list; shipping splits and weights.
 - 2) Front elevation indicating location of devices and instruments.
 - 3) Sections through switchboard showing space available for conduits.
 - b. Conduit entrance locations and requirements.
 - c. Nameplate legends.
 - d. Configuration, size and number of bus bars for each phase and current rating of buses.
 - e. Ground bus.
 - f. Neutral bus.
 - g. Short circuit ratings of switchboards and overcurrent protective devices, and bus withstand rating.
 - h. Instrument details; enclosure types and details.
 - i. Wiring diagrams: power, signal and control wiring.
 - j. Utility company's metering provisions with indication of approval by utility company.
 - k. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - l. UL listing for series rating of installed devices.
 - 2. Contractor to submit 1/4" scale floor plans with switchboard locations and required clearances and service space around equipment.
- C. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- E. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.
- F. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations, configurations, and ratings of switchboard and major components on single-line diagrams and plan layouts.
 - 2. Operation and Maintenance Data:

- a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
- b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
- d. Include Manufacturer Seismic Qualification Certification and Installation Seismic Qualification Certification.
- e. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Obtain switchboards from one source and by single manufacturer.
- B. Regulatory Requirements:
 1. Comply with NFPA 70 for components and installation.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- C. Certifications:
 1. Furnish Owner Representative with Manufacturer Seismic Qualification Certification: Submit certification that switchboards, accessories, and components will remain internally intact to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems. Include the following:
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Furnish Owner Representative with Installation Seismic Qualification Certification: Submit certification that switchboards, accessories, and components will remain in place without separation of any parts when subjected to the seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems and will be fully operational after the seismic event. Include the following:
 - a. Detailed description of equipment supports and seismic restraints on which the certification is based and their installation requirements.
 - b. Certification shall bear the seal and signature of an Engineer registered and licensed in the State of California.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction

debris, and traffic. Provide temporary heaters in switchboards as required to prevent condensation.

- B. Deliver switchboards in (48") maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.
- C. Handle switchboards in accordance with NEMA PB 2.1 and ANSI/NECA 400. Use factory- installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

- A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.
 - 2. Control-Power Fuses: Equal to 10% of amount installed for each size and type, but no fewer than 2 of each size and type.

1.10 UNIVERSITY STANDARDS

- A. Switchboards and Panel boards
 - 1. All switchboards, panel boards, distribution boards, etc. that have a rating above 225A or a phase to ground voltage above 150V shall use distribution breakers that can be installed and removed without the manipulation of line side hardware (Nuts, Bolts or Screws) on the line side of the circuit breaker. The manipulation of any one circuit breaker must not disturb or interrupt the operation of any other or adjacent circuit breaker in the assembly
 - 2. Provide 20% of the panel board, switchboard or distribution board breaker mounting space as spare space.

3. All low voltage distribution equipment, panel boards, switchboards, distribution boards, etc. are to be located inside the building or structure. Outdoor distribution equipment is not permitted.
4. All electrical distribution equipment shall be located in an electrical room or similar occupancy that is not accessible to the general public.
5. All electrical distribution equipment shall be provided with locking covers or provisions for padlocks.
6. All circuit breakers that carry a rating over 70A 1, 2 or 3 pole shall have permanently installed provisions to lock the breakers in the off position.
7. Flush mounted panel boards shall have (1) .75 inch conduit stubbed into the accessible ceiling space above the panel per 3 available circuit breaker spaces.
8. All circuit breakers that have trip or protection parameters that are adjustable will have facilities to seal off and protect these parameters from further tampering or adjustment.
9. Circuit breaker will be fully rated for the fault current that they will encounter in their installation. The use of series rated devices to achieve a system that is of sufficient fault current duty for the installation conditions is not acceptable.
10. Perform 3rd party acceptance testing for switchboards and panelboards per the current NETA ATS. Test each breaker 400A 3 pole or greater using NETA ATS.
11. Low voltage transformers are to have an energy rating of CSL3 or higher.
12. Perform 3rd party acceptance testing for transformers per the current NETA ATS.
13. Motor starters that require overload protection shall use solid state current sensing type overload protection. Thermal element overload protection is not acceptable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D (Basis of Design)
- B. Eaton

2.2 RATINGS

- A. Nominal system voltage: As indicated on the drawings or scheduled.
- B. Main bus continuous amp: As indicated on the drawings or scheduled.
- C. Short circuit current rating: As indicated on drawings.
- D. Brace switchboard components to withstand mechanical forces for symmetrical fault current shown.

2.3 CONSTRUCTION

- A. NEMA PB 2, UL 891
- B. Free-standing, dead-front type; vertical sections bolted together; sides and rear covered with removable bolt-on covers; adequate ventilation within enclosure; supporting frame: steel angles rigidly fastened together, with same outside dimensions as the enclosure.
- C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.
- D. Incoming lug locations: Top or bottom, as applicable per drawings.
- E. Environmental Limitations:
 - 1. Ambient temperatures: Not exceeding 40°C.
 - 2. Altitude: Not exceeding 500 feet
 - 3. Temperature rise: Not to exceed 65°C over a 40°C ambient environment, with no derating required.
- F. Bus:
 - 1. Material: Copper; copper: 98% conductivity. The bus bars shall have sufficient cross-sectional area to meet UL 891 temperature rise requirements through actual tests. The bus bars shall be standard density rated for 1000 amperes per square inch copper.
 - 2. Connections:
 - a. Bolted:
 - 1) Not fewer than 4 bolts for each 4" x 4" contact.
 - 2) Not fewer than 2 bolts for each 2" x 2" contact.
 - 3) Grade 5 bolts and conical spring-type washers.
 - 4) Clamp joints are not allowed.
 - 3. Sizing: Standard size, based on 65°C over 40°C.
 - 4. Main Phase Buses: Three phase, 4 wire; fully rated; uniform capacity for entire length of switchboard; ampacity as indicated on drawings; rated for the main protective device frame size or main incoming conductors.
 - 5. All feeder device line and load connection straps: Rated to carry current rating of device frame (not trip rating).
 - 6. Support for Buses: Mounted on high-impact, non-tracking insulated supports; joints in the vertical bus are not permitted.
 - 7. Bus arrangement: A-B-C (left to right, top to bottom, front to rear).
- G. Ground Bus: extend length of switchboard.

1. 1/4" x 2" minimum-size, hard-drawn copper of 98% conductivity, equipped with pressure connectors for feeder ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection.
- H. Neutral Bus: 100% of the ampacity of phase buses, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- I. Main incoming compartment.
- J. Hinged Front Doors: Allow access to metering and accessory compartments; concealed hinges; fastened by head bolts.
- K. Cable Supports: For each vertical section.
- L. Vertical Insulating Barrier: Between the device compartment and bus compartment.
- M. Vertical Insulating Barrier: Between the bus compartment and cable compartment.
- N. Barriers: Between adjacent sections.
- O. Hinged Front Doors: Over device compartments, with concealed hinges and fastened by hex head bolts.
- P. Hinged Rear Doors and Compartment Covers: With concealed hinges and fastened by hex head bolts.
- Q. Bus Connections: Extend from load side of devices into rear compartment for connections to outgoing cables.
- R. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
 1. Pull Section: Matched and aligned with basic switchboard
- S. Future Provisions: Fully equip spaces for future devices with bussing, mounting brackets, supports, and appurtenances, insulated and braced for short circuit currents, with continuous current rating as indicated on drawings. Extension of phase, neutral, and ground buses from both ends.
- T. Adequate lifting means.
- U. Dimensions: 90" maximum height, excluding floor sills, lifting members and pull boxes.

- V. Line and Load Terminations: Mechanical type accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on drawings suitable for number, size and trip ratings.
- W. Enclosure: Steel, NEMA 250, Type 1:
 - 1. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

2.4 SHORT CIRCUIT CURRENT RATING

- A. Each switchboard with minimum short circuit current rating as indicated on drawings.
- B. Switchboards: Marked with their maximum short circuit current rating at supply voltage.
- C. Switchboards: Fully rated. Series rated switchboards are not acceptable.

2.5 SURGE PROTECTIVE DEVICES (SPD)

- A. Furnished under 26 43 00 - Surge Protective Devices
- B. IEEE C62.41.1; integrally mounted, plug-in style, solid-state, parallel-connected, suppression and filtering modules
- C. Per requirements in Section 26 43 00 - Surge Protective Devices

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Circuit breakers must be able to be installed and removed without manipulating hardware (nuts, bolts, fasteners, etc.) to connect the line side of the circuit breaker to the buss.
- B. Molded-Case Circuit Breaker: NEMA AB 1, NEMA AB 3, UL 489; lockable handle; interrupting capacity to meet available fault current:
 - 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 225 A and below.
 - 2. Electronic (solid-state microprocessor based) trip unit circuit breakers: digital true RMS sensing trip units; interchangeable in the field within the frame size (field-replaceable rating plug to determine the breaker trip rating), field-adjustable settings and the following trip functions for circuit breaker frame sizes 250 A - 1200 A:
 - a. Instantaneous trip
 - b. Long- and short-time pickup levels

- c. Long- and short-time time delay adjustments with I²t response
 - d. Ground-fault pickup level, time delay, and I²t response
 - 3. Current-Limiting Circuit Breakers: No fusible element, frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 4. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with current-limiting fuses; trip activation on fuse opening or on opening of fuse compartment door.
 - 5. Listed for 100% of breaker's continuous ampere rating.
- C. Circuit Breaker Electronic Trip Units general characteristics:
 - 1. Circuit breakers, with solid-state microprocessor-based trip units:
 - a. Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
 - b. Trip units shall be removable to allow for field upgrades.
 - c. Trip units shall incorporate "True RMS Sensing."
 - 2. Solid-state elements shall provide functions as indicated above.
 - 3. Adjustments shall be made using non-removable, discrete steps.
 - 4. Sealable transparent cover shall be provided over adjustments.
 - 5. Adjustable long-time pickup (I_r) and delay shall be available in an adjustable rating plug that is UL listed as field-replaceable. Adjustable rating plug shall allow for five minimum long-time pickup settings from 0.4 to 1.0 times the sensor plug (I_n). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be at least three bands.
 - 6. Short-time pickup shall allow for five minimum settings from 1.5 to 10 times I_r. Short-time delay shall be at least three bands with I²t ON and OFF.
 - 7. Instantaneous settings on the trip units shall be available in five minimum bands from 2 to 15 times I_n. The instantaneous settings shall also have an OFF setting when short-time pickup is provided.
 - 8. Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.
 - 9. Trip unit shall indicate:
 - a. Long-time fault
 - b. Short-time fault
 - c. Instantaneous fault
 - d. Ground fault, where provided
 - 10. Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
 - 11. Trip unit shall contain means to conduct circuit breaker test, or via separate test kit.

12. Breaker shall be equipped with externally accessible test points to be used for field testing.
 13. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.
 14. Trip units shall be provided with the following standard features:
 - a. True RMS sensing
 - b. LI
 - c. LSI
 - d. LSIG/Ground-fault trip
 - e. Ground Fault Alarm (no trip), with external relay, where required
 - f. Adjustable rating plugs
 - g. LCD or LED - Long-time pickup
 - h. LCD or LED - Trip indication
 - i. Digital Ammeter
 - j. Communications
 - k. LCD dot matrix display
 - l. Advanced user interface
 - m. Protective relay functions
 - n. Neutral protection
 - o. Incremental fine tuning of settings
 - p. Selectable long-time delay bands
 - q. Power measurement
 - r. Maximum peak demand (measure of average power over a 15-minute period) continuously recorded over a one-year period.
- D. Ground Fault protection equipment on breakers, where indicated: Integrally mounted relay and trip unit, push-to-test feature and ground fault indicator:
1. Ground-fault protection with at least three adjustable short-time delay settings and three trip- time delay bands; adjustable current pickup with maximum setting of 1200 amps. Arrange to provide protection for the following:
 - a. Three-wire circuit or system
 - b. Four-wire circuit or system
 - c. Four-wire, double-ended substation
 2. Trip units shall be capable of the following types of ground-fault protection: source ground return, residual, zero sequence, and modified differential. Ground fault sensing systems shall be changed in the field.
 3. Neutral current transformers shall be provided for 4-wire system.
 4. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times I_n . The ground-fault settings for circuit breakers above 1200 A shall be in minimum three bands up to 1200 A.

5. Ground-Fault Relay: UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and 3-phase current transformer/sensor.

2.7 CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

- A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.
- B. 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.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control components mounted within assembly, such as relays, pushbuttons, switches, etc.: Suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.
- E. Control Wiring: Factory installed, with bundling, lacing, and protection included; flexible conductors for #8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for all control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchboard, with wire markers at each end of control wiring.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- B. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

- D. Furnish overhead circuit breaker lifting devices, mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.
- E. Furnish set of tools for manually charging circuit breaker stored energy device.
- F. Lockout Devices: Circuit breakers with integral, lockout/tagout devices.

2.9 CUSTOMER METERING

- A. Per requirements in Section 26 27 13 - Electrical Metering.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.
- B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:
 - 1. Concrete: Per requirements in Division 03 - Concrete.
 - 2. Dimensions: Per requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.
- D. Coordinate utility company metering equipment requirements.
- E. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

- A. Examine areas and surface to receive switchboards for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that space indicated for switchboard mounting meets code-required working clearances.
- C. Notify Owner Representative of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

- A. Install switchboard in accordance with NEMA PB 2.1 and ANSI/NECA 400.
- B. Switchboard mounting and seismic restraints:
 - 1. Install switchboard anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State of California, and to comply with Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems for seismic criteria.
 - 2. Bolt switchboards to concrete housekeeping pads, using anchor bolts in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pads.
 - 3. Install bushing assemblies for anchor bolts for seismic restraints per requirements in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- C. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification for each switchboard, every instrument, overcurrent protective device and disconnect device. Attach nameplate to exterior of each switchboard using small corrosion-resistant metal screws and rivets. Do not use contact adhesive. Indicate switchboard manufacturer's name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA 3-phase symmetrical) and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include circuit, load and area served, voltage/phase rating, and fuse size and type, when applicable Request inspection from the University IOR 10 days prior to planned panel energization. Have all required testing complete and available for inspection.
- D. Provide framed, printed operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install switchboards in dedicated electrical space per NFPA 70, and as indicated on drawings.
- F. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- G. Install fuses in fusible switch at job site per requirements in Section 26 28 13 - Fuses.
- H. Install surge arrestors in cable termination compartments and connect to each phase of circuit, per requirements in Section 26 43 00 - Surge Protective Devices.

- I. Connect surge protective devices to switchboard bus per requirements in Section 26 43 00 - Surge Protective Devices.
- J. Install utility company metering equipment, devices and wiring in conformance with serving utility requirements.
- K. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- L. Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.4 CONNECTIONS

- A. Ground switchboards according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Connect power and control wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

- A. Inspect switchboards for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.
- B. Test continuity of each circuit.
- C. Test switchboards per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests.
- D. Interpret test results in writing and submit to Owner Representative.
- E. Test switch operators once after energizing.

3.6 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer- supplied paint kit. Leave remaining paint with Owner Representative.

3.7 ADJUSTING

- A. Set field-adjustable circuit breakers trip settings or change the trip settings to values indicated on drawings or recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.
- B. Field adjustments or changing of trip setting and adjustment or replacement of equipment to comply with Section 26 05 73 - Power System Studies; no additional cost to Owner.

3.8 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

- A. Provide training session by manufacturer for one workday at a job location, to train the Owner's personnel in the operation and maintenance of switchboards.

END OF SECTION 26 24 13

SECTION 26 24 16.13 - LIGHTING AND APPLIANCE PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- E. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- F. Section 26 05 53 - Electrical Systems Identification
- G. Section 26 05 73 - Power System Studies
- H. Section 26 08 12 - Power Distribution Acceptance Tests
- I. Section 26 08 13 - Power Distribution Acceptance Test Tables
- J. Section 26 27 13 - Electrical Metering

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes circuit breaker type lighting and appliance branch circuit panelboards as shown on drawings and as scheduled. Panels covered in this section are between 0-225A ratings. See "Distribution Boards" spec section 26 24 16.16 for ratings above 225A.

1.4 REFERENCE STANDARDS

- A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

- C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- D. NEMA PB 1 - Panelboards
- E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
- F. NFPA 70 - National Electrical Code
- G. UL 50 - Enclosures for Electrical Equipment
- H. UL 67 - Panelboards
- I. UL 486A-486B - Wire Connectors
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- K. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.
- B. Shop Drawings:
 - 1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
 - 2. Submit 1/4" scale electrical room floor plans with panelboard locations.
- C. Partial Submittals:
 - 1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Reports:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
1. Project Record Documents:
 - a. Record actual locations of panelboards and record actual circuiting arrangements.
 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
 - d. Include spare parts data listing, source, and current prices of replacement parts and supplies.
 - e. Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.6 QUALITY ASSURANCE

- A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by single manufacturer.
- B. Regulatory Requirements:
1. Comply with NFPA 70.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- C. Certifications:
1. Furnish Owner's Representative with manufacturer's Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will remain internally intact to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems. Include the following:
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Furnish Owner's Representative with Installation Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will remain in place without separation of any parts when subjected to the seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems and will be fully operational after the seismic event. Include the following:

- a. Detailed description of panelboard anchorage devices and seismic restraints on which the certification is based, and their installation requirements.
- b. Certification shall bear the seal and signature of an Engineer registered and licensed in the State of California.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

- A. Extra Materials:
 1. Furnish Owner's Representative with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D (Basis of Design)
- B. Eaton
- C. Or equal

2.2 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

- A. NEMA PB 1, UL 67
- B. Fabrication:
 1. Factory assembled.
 2. Door-in-door construction.

3. Incoming feeder lugs: copper conductors.
 4. Multiple lugs to match number of conductors per phase.
 5. Sub-feed (double) lugs, or feed-through lugs where indicated.
 6. Filler plates.
 7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.
- C. Panelboard Buses:
1. Copper
 2. Ampere rating as scheduled
 3. Ground bus: uninsulated, bonded to panelboard cabinet
 4. Insulated neutral bus: 100% of phase bus rating
- D. Molded-Case Circuit Breakers:
1. NEMA AB 1, UL 489
 2. Panelboards operating at a voltage over 150V phase to ground must employ circuit breakers that can be installed and removed without manipulating hardware (nuts, bolts, fasteners, etc.) to connect to the line side of the circuit breaker to panelboard buss.
 3. Panelboards operating at a voltage less than 150V phase to ground must employ circuit breakers that have positive trip indication on circuit breakers sized 5-100A. Positive trip indication and contrasting LED, contrasting flag, or indicating window that changes color when the circuit breaker is in the tripped position. This indication must not be visible or illuminated when the circuit breaker is in the "on" or "off" state.
 4. Quick-make, quick-break, with thermal-magnetic trip.
 5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
 6. Ampere rating as scheduled.
 7. Listed as Type SWD for lighting circuits.
 8. Listed as Type HACR for air conditioning equipment circuits.
 9. Bussing, device mounting hardware, and steel knockouts in dead front where "space" is indicated.
 10. Tandem circuit breakers are not acceptable.
 11. Locks on trip handles where indicated.
 12. Ground fault equipment protection (GFEP), rated 30 mA trip, to provide equipment protection for branch circuits feeding electrical heat tracing, where indicated.
 13. Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated.
- E. Cabinet
1. NEMA 250, UL 50

2. NEMA Type 1, Type 3R (outdoor locations) enclosure.
3. Front (trim) flush and surface mounted with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel.
7. Manufacturer's standard gray enamel finish over prime coat] [Manufacturer's prime coat finish for cabinets mounted in finished areas for field paint to match wall color by others and manufacturer standard gray enamel finish over prime coat for cabinets mounted in unfinished areas. For field painted panels, door hinges shall be concealed inside panel.

2.3 METERS

- A. Provide separate metering compartments with digital meter in accordance with Section 26 27 13 - Electrical Metering.

2.4 SHORT CIRCUIT CURRENT RATING

- A. Each panelboard with minimum short circuit current rating as indicated on drawings.
- B. Panelboards marked with their maximum short circuit current rating at supply voltage.
- C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.5 SURGE PROTECTIVE DEVICES (SPD)

- A. Furnished under 26 43 00 - Surge Protective Devices
- B. Per requirements in Section 26 43 00 - Surge Protective Devices.

2.6 SPARE CONDUITS

- A. A. Spare conduits per requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

- A. Instruct manufacturer about the location of additional wiring gutter space when required (i.e., top, bottom, right, left, or combination).

- B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).
- C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.
- D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.
- E. Verify that "touch-up" paint kit is available for repainting.
- F. Coordinate painting of cabinets in finished areas with work performed under Division 09 - Finishes.

3.2 EXAMINATION

- A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.
- B. Notify Owner's Representative of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

- A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.
- C. Panelboard mounting and seismic restraints:
 - 1. Install panelboard anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State of California and to comply with Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems for seismic criteria.
 - 2. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
 - 3. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Install two rows of steel slotted channel, with a minimum of 4 attachment points, for each panelboard section.

5. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.
- D. Install top breaker handle a maximum of 6'-7" above finished floor or working platform with handle in its highest position.
- E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque- tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.
- F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinator with Owner's Representative and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner's Representative.
- G. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small metal screws or rivets. Do not use contact adhesive.
 1. Include panelboard name, amperage, voltage, phase, and number of wires. Label spare circuits as SPARE. Leave spare breakers in OFF position.
- H. Room numbers used shall be those used by Owner's Representative except as otherwise directed by Owner's Representative.
- I. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.
- J. Install filler plates in unused spaces.
- K. Install three 3/4" spare conduits stubbed into accessible ceiling space or space designated to be ceiling space in the future for all flush-mounted panelboards. Install conduits in accordance with requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.
- L. Install three 3/4" spare conduits stubbed into ceiling space above and below for panelboards that serve loads on levels other than that where the panelboard is located. Install conduits in accordance with requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.

3.4 CONNECTIONS

- A. Ground panelboards according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment, anchorage, and grounding.
- B. Maintain proper phasing for multi-wire circuits.
- C. Test main circuit breakers in accordance with requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.
- D. Interpret test results in writing and submit to Owner's Representative.
- E. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energization of panelboards. Request inspection from the University IOR 10 days prior to planned panel energization. Have all required testing complete and available for IOR's inspection.
- F. Check panelboards for electrical continuity of circuits and for short-circuits prior to energization.
- G. Submit ammeter readings for all panelboard feeders indicating normal operating load and phase balance.
- H. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
 - 1. Perform measurements during period of normal working load as advised by Owner's Representative.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner's Representative to avoid disrupting critical 24-hour services, such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 10% between phase loads, within a panelboard, is not acceptable.

5. Reconnect or redistribute circuits or circuit breakers to achieve balanced condition. Revise circuit directory to reflect circuiting changes required to balance phase loads.

3.6 REPAINTING

- A. Remove paint splatters or other marks from surface of panelboards.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner's Representative.

3.7 ADJUSTING

- A. Adjust fronts, covers, hinges, and locks.

3.8 CLEANING

- A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 26 24 16.13

SECTION 26 24 16.16 - DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- E. Section 26 05 53 - Electrical Systems Identification
- F. Section 26 05 73 - Power System Studies
- G. Section 26 08 12 - Power Distribution Acceptance Tests
- H. Section 26 27 13 - Electrical Metering

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes circuit breaker type and fusible switch type power distribution panelboards as shown on drawings and as scheduled. Distribution Panelboards included in this section are panelboards operating over 225A.

1.4 REFERENCE STANDARDS

- A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- D. NEMA FU 1 - Low-Voltage Cartridge Fuses

- E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- F. NEMA PB 1 - Panelboards
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less
- H. NFPA 70 - National Electrical Code
- I. UL 50 - Enclosures for Electrical Equipment
- J. UL 67 - Panelboards
- K. UL 486A - 486B - Wire Connectors
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- M. UL 512 - Fuseholders
- N. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.
- B. Shop Drawings:
 - 1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
 - 2. Submit 1/4" scale electrical room floor plans with panelboard locations.
- C. Partial Submittals:
 - 1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Report:

1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
1. Project Record Documents:
 - a. Record actual locations of panelboards and record actual circuiting arrangements.
 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
 - d. Include spare parts data listing, source, and current prices of replacement parts and supplies.
 - e. Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.6 QUALITY ASSURANCE

- A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by a single manufacturer.
- B. Regulatory Requirements:
1. Comply with NFPA 70.
 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- C. Certifications:
1. Furnish Owner Representative with manufacturer's Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, and components will remain internally intact to withstand seismic forces defined in Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems. Include the following:
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Furnish Owner Representative with Installation Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will remain in place without separation of any parts when subjected to the seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems and will be fully operational after the seismic event. Include the following:

- a. Detailed description of panelboard anchorage devices and seismic restraints on which the certification is based, and their installation requirements.
- b. Certification shall bear the seal and signature of an Engineer registered and licensed in the State of California.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.
- B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

- A. Extra Materials:
 1. Furnish Owner Representative with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D (Basis of Design)
- B. General Electric
- C. Cutler Hammer
- D. or equal

2.2 POWER DISTRIBUTION PANELBOARDS

- A. NEMA PB 1, UL 67.

- B. Distribution panelboards must be mounted in equipment enclosures that are 32" wide or larger.
- C. Distribution panelboards rated 225A or greater shall have circuit breakers that can be installed and removed without manipulating hardware (nuts, bolts, fasteners, etc.) to connect the line side of the circuit breaker to the distribution panelboard buss.
- D. Fabrication:
 - 1. Factory assembled
 - 2. Individualized breaker dead-front cover door-in-door construction
 - 3. Incoming feeder lugs: copper conductors
 - 4. Multiple lugs to match number of conductors per phase
 - 5. Sub-feed (double) lugs, or feed-through lugs where indicated
 - 6. Filler plates
 - 7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire- binding screws for #10 AWG or smaller conductors.
- E. Panelboard Buses:
 - 1. Copper
 - 2. Ampere rating as scheduled
 - 3. Ground bus: uninsulated, bonded to panelboard cabinet
 - 4. Insulated neutral bus where applicable: 100% of phase bus rating
- F. Molded-Case Circuit Breakers:
 - 1. NEMA AB 1, UL 489
 - 2. Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors.
 - 3. Quick-make, quick-break, with thermal-magnetic trip and electronic (solid- state microprocessor-based) trip.
 - 4. Equipped with individually insulated, braced, and protected connectors
 - 5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
 - 6. Ampere rating as scheduled.
 - 7. Front face flush with each other.
 - 8. Large, permanent, individual circuit numbers affixed to each breaker in uniform position.
 - 9. Tripped indication clearly shown by breaker handle taking position between "ON" and "OFF."
 - 10. Listed as Type HACR for air conditioning equipment circuits.
 - 11. Bussing, device mounting hardware, and steel knockouts in dead front where "space" is indicated.
 - 12. For 100A frame size and below: thermal-magnetic trip.
 - 13. For 100A frame size and above: electronic trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each

adjustment shall have discrete settings and shall be independent of all other adjustments.

14. Locks on trip handles where indicated.
15. Breakers 400A frame size and larger to be microprocessor controlled with LSI or LSIg trip functions.

G. Cabinet

1. NEMA 250, UL 50
2. NEMA Type 1, Type 3R (outdoor locations) enclosure.
3. Four-piece front (trim) surface mounted with door over the front, with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch except omit door in fusible switch panelboard.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel.

2.3 METERS

- A. Provide separate metering compartments with digital meter in accordance with Section 26 27 13 - Electrical Metering.

2.4 SHORT CIRCUIT CURRENT RATING

- A. Each panelboard with minimum short circuit current rating as indicated on drawings.
- B. Panelboards marked with their maximum short circuit current rating at supply voltage.
- C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.5 SURGE PROTECTIVE DEVICES (SPD)

- A. Furnished under 26 43 00 - Surge Protective Devices
- B. Per requirements in Section 26 43 00 - Surge Protective Devices.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

- A. Instruct manufacturer about the location of additional wiring gutter space when required, i.e. top, bottom, right, left, or combination.

- B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).
- C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.
- D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.
- E. Verify that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

- A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.
- B. Notify Owner Representative of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

- A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.
- C. Panelboard mounting and seismic restraints:
 - 1. Install panelboard anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State of California, and to comply with Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems for seismic criteria.
 - 2. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
 - 3. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Install two rows of steel slotted channel, with a minimum of four attachment points, for each panelboard section.
 - 5. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

- D. Install top breaker handle a maximum of 6'-7" above finished floor or working platform, with handle in its highest position.
- E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A -486B.
- F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads before completing load balancing) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinate with Owner Representative and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner Representative.
- G. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.
 - 1. Indicate panelboard name, amperage, voltage, phase, and number of wires.
- H. Label spare circuits as SPARE. Leave spare breakers in OFF position.
- I. Room numbers used shall be those used by Owner Representative except as otherwise directed by Owner Representative.
- J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.
- K. Install filler plates in unused spaces.
- L. Install fuses in fusible switches, per requirements in Section 26 28 13 - Fuses.
- M. Request inspection from the University IOR 10 days prior to planned panel energization. Have all required testing complete and available for IOR inspection.

3.4 CONNECTIONS

- A. Ground panelboards according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment, anchorage, and grounding.
- B. Test circuit breakers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests.
- C. Interpret test results in writing and submit to Owner Representative.
- D. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energizing panelboards.
- E. Check panelboards for electrical continuity of circuits and for short-circuits prior to energizing.
- F. Submit ammeter readings for all panelboard feeders indicating normal operating load and phase balance.
- G. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
 - 1. Perform measurements during period of normal working load as advised by Owner Representative.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner Representative to avoid disrupting critical 24- hour services, such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 10% between phase loads, within a panelboard, is not acceptable.
 - 5. Reconnect or redistribute circuits or circuit breakers to achieve balanced condition. Revise circuit directory to reflect circuiting changes required to balance phase loads.

3.6 REPAINTING

- A. Remove paint splatters or other marks from surface of panelboards.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer- supplied paint kit. Leave remaining paint to Owner Representative.

3.7 ADJUSTING

- A. Adjust fronts, covers, hinges, and locks.
- B. Circuit Breakers: Set field-adjustable trip settings or change the trip settings recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.

3.8 CLEANING

- A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 26 24 16.16

SECTION 26 27 13 - ELECTRICAL METERING

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- E. Section 26 05 53 - Electrical Systems Identification
- F. Section 26 08 12 - Power Distribution Acceptance Tests
- G. Section 26 11 13 - Primary Unit Substations
- H. Section 26 13 16 - Medium-Voltage Fusible Interrupter Switchgear
- I. Section 26 13 19 - Medium-Voltage Vacuum Interrupter Switchgear
- J. Section 26 13 23 - Medium-Voltage Pad-Mounted Switchgear
- K. Section 26 23 00 - Low-Voltage Switchgear
- L. Section 26 24 13 - Switchboards
- M. Section 26 28 13 - Fuses
- N. Section 26 43 00 - Surge Protective Devices

1.2 REFERENCE

- A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes equipment for energy and demand metering by Owner. It also includes options that provide for monitoring or automatic control of demand at a remote location.

1.4 REFERENCE STANDARDS

- A. ANSI C12.1 - Code for Electricity Metering
- B. ANSI C12.7 - Requirements for Watthour Meter Sockets
- C. ANSI C12.9 - Test Switches for Transformer-Rated Meters
- D. ANSI C12.10 - Watthour Meters
- E. ANSI C12.11 - Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV Through 69 kV NSV)
- F. ANSI C12.18 - Protocol Specification for ANSI Type 2 Optical Port
- G. ANSI C12.19 - Utility Industry End Device Data Tables
- H. ANSI C12.20 - Electricity Meters-0.2 and 0.5 Accuracy Classes
- I. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments
- J. IEEE C37.90.1 - Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- K. IEEE C57.13 - Standard Requirements for Instrument Transformers
- L. IEEE C62.11 - Metal-Oxide Surge Arresters for Alternating Current Power Circuits
- M. IEEE C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits
- N. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- O. IEEE C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
- P. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

- Q. NECA 400 - Recommended Practice for Installing and Maintaining Switchboards
- R. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- S. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- T. NEMA AB 3 - Molded-Case Circuit Breakers and Their Applications
- U. NEMA EI 21.1 - Instrument Transformers for Revenue Metering (110KV BIL and Less)
- V. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- W. NEMA LA 1 - Surge Arresters
- X. NEMA PB 2 - Dead-Front Distribution Switchboard
- Y. NFPA 70 - National Electrical Code
- Z. UL 50 - Standard for Enclosures for Electrical Equipment (1995)
- AA. UL 98 - Enclosed and Dead-Front Switches
- BB. UL 414 - Standard for Meter Sockets (1999)
- CC. UL 467 - Grounding and Bonding Equipment
- DD. UL 486A-486B - Wire Connectors
- EE. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- FF. UL 891 - Dead-Front Switchboards
- GG. ASTM D1535 - Standard Practice for Specifying Color by the Munsell System

1.5 SUBMITTALS

- A. Product Data: For metering equipment, components and accessories indicated:
 - 1. Include data on features, components, and complete description; submit catalog cut sheets showing electrical characteristics and ratings.
 - 2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe operating sequences, both automatic and manual.

- B. Shop Drawings:
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field installed wiring, and show circuit protection features.
- C. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- E. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations and ratings of metering equipment on single-line diagrams and plan layouts.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures
 - b. and intervals, and preventive maintenance instructions.
 - c. Include manufacturer's written instructions for testing.
 - d. Include spare parts data listing, source, and current prices of replacement parts and supplies.
 - e. Include manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.6 QUALITY ASSURANCE

- A. Obtain metering equipment from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
- C. Certifications:
 - 1. Furnish Owner's Representative with manufacturer's Seismic Qualification Certification: Submit certification that metering equipment, accessories, and components will remain internally intact to withstand seismic forces defined in

Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems. Include the following:

- a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Furnish Owner's Representative with Installation Seismic Qualification Certification: Submit certification that metering equipment, accessories, and components will remain in place without separation of any parts when subjected to the seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems. Include the following:
 - a. Detailed description of equipment supports and seismic restraints on which the certification is based and their installation requirements.
 - b. Certification shall bear the seal and signature of an Engineer registered and licensed in the State of California.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter center as specified in NECA 400. Use factory installed lifting provisions. Handle carefully to avoid damage to assembly internal components, enclosure, and finish.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

- A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 1. Potential Transformer Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.
 2. Control-Power Fuses: Equal to 10% of amount installed for each size and type, minimum of 2 of each size and type.
 3. Fuses for Fused Switches: Equal to 10% of amount installed for each size and type, minimum of 3 of each size and type.

1.10 UNIVERSITY STANDARDS

- A. The campus has specified some equipment as a "Sole Source Justification" to match the existing infrastructure in functionality. Note references to specific manufactures in the following section.
- B. Instrumentation and Control for Electrical Systems
 - 1. The campus uses a SCADA system for the control and monitoring of the campus high and medium voltage system as well as the acquisition of power meter data back to Facility Service's automated recharge system.
 - 2. All electric meters will be connected to the SCADA system for remote monitoring of total energy usage as well as real time data. Consult a University representative about current power meters in use that may be applied to the specific project. Consult a University Representative for compunctions options which will include either a mod bus connection or an Ethernet connection. Provide necessary hardware and cabling to facilitate meter connection and integration.
 - 3. Connect control power to power meters at 120V or less AC or DC

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICAL METERING FOR CALIFORNIA POLYTECHNIC STATE UNIVERSITY

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four- wire systems and with the following features:
 - 1. Manufacturers:
 - a. Square D
 - b. Schweitzer Engineering Labs (SEL).
 - c. Approved equal
 - 2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: +/-0.5%
 - b. Phase-to-Phase Voltages, Three Phase: +/-1%
 - c. Phase-to-Neutral Voltages, Three Phase: +/-1%
 - d. Megawatts: +/-2%
 - e. Megavars: +/-2%
 - f. Power Factor: +/-2%
 - g. Frequency: +/-0.5%
 - h. Megawatt Demand: +/-2%; demand interval programmable from 5 to 60 minutes
 - i. Accumulated Energy, Megawatt Hours: +/-2%. Accumulated values unaffected by power outages up to 72 hours

- j. Maximum demand (measure of average power demand over a 15-minute period) continuously recorded over a one-year period.
 - k. Total Harmonic Distortion, Amperes
 - l. Total Harmonic Distortion, Volts
 - m. Individual Amperage Harmonics through the 63rd
 - n. Integral Communications Port
3. Mounting: Display and control unit flush or semi-flush, mounted in instrument compartment door.
- B. Instrumentation:
- 1. Manufacturers:
 - a. Square D
 - b. General Electric
 - c. Siemens
 - d. Cutler-Hammer
 - e. Approved equal
 - 2. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
 - a. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 - 1) 600 V and below: external PTs not required; fused potential connection.
 - b. Current Transformers: Bar type; ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments; shorting test blocks: 10 poles - 4 potential and 6 current, mounted with meter or in accessible location.
 - c. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
 - d. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit breaker ground-fault protection.
- C. Data Communications:
- 1. Means to transmit data to central control and monitoring system.
 - a. Provide meter with Onboard TCIP connectivity.
 - b. Keypad and scrollable display for local reading of measured values.
 - 2. Kilowatt-Hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand.
 - a. Voltage and Phase Configuration: Designed for use on circuits with voltage rating and phase configuration indicated for its application.

- b. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
- c. Demand Signal Communication Interface: Match signal to building automation system input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
- d. Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.
- e. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
- f. Identification: Comply with Section 26 05 53 - Electrical Systems Identification.
- g. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
- h. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.
 - 1) Type: Split and solid core.
- i. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.
- j. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
- k. Solid State Breakers for Energy Monitoring (provided under other specification sections). Identified breakers shall monitor energy use and report to the building automation system.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate adjustment and programming of metering equipment with manufacturer.
- B. Instruct manufacturer about the location of incoming lugs (i.e., top or bottom feed based on incoming feeder entrance location).
- C. Coordinate with miscellaneous trades for equipment foreign to electrical installation to be outside of dedicated electrical space.
- D. Verify with manufacturer that "touch-up" paint kit is available for repainting.

- E. Coordinate meter data transmission with Supervisory Control and Data Acquisition (SCADA) System to integrate electrical system metering data with SCADA GUI and Energy Code reporting requirements.

3.2 EXAMINATION

- A. Examine areas and surface to receive modular meter center for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that space indicated for modular meter center mounting meets code-required working clearances.
- C. Notify Owner's Representative of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

- A. Comply with installation requirements in NECA 1.
- B. Connect all energy meter to the campus SCADA system. Coordinate with University to integrate into the current SCADA HMI and database system.
- C. Install current transformer cabinets, meter cabinets or meter sockets to comply with requirements of electrical power utility company. Install empty conduits for metering leads and extend grounding connections as required by utility company.
- D. Install modular meter center in accordance with NECA 400.
- E. Modular meter center mounting and seismic restraints:
 - 1. Install modular meter center anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State of California, and to comply with Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems for seismic criteria.
 - 2. Bolt modular meter center to concrete housekeeping pad, using anchor bolts in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pad.
 - 3. Install bushing assemblies for anchor bolts for seismic restraints per requirements in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
- F. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification for modular meter center, every instrument, overcurrent protective device, and disconnect device. Attach nameplate to exterior of modular meter center using small corrosion-resistant metal screws and rivets. Do not use

contact adhesive. Indicate modular meter center manufacturer's name and drawing number, name, amperage, voltage, phase, number of wires, short circuit current rating (amp, RMS symmetrical and MVA three-phase symmetrical), and momentary and fault-closing ratings (amp, RMS asymmetrical). For each overcurrent protective device and disconnect device, include tenant name, load served, voltage/phase rating, and fuse size and type, when applicable.

- G. Install modular meter center in dedicated electrical space per NFPA 70, and as indicated on drawings.
- H. Tighten electrical connectors and terminal according to equipment manufacturer's published torque- tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- I. Install fuses in fusible switch at job site per requirements in Section 26 28 13 - Fuses.
- J. Mount meters in the locations indicated on the drawings. Mounting height: 5'-6" or less from finished floor.

3.4 FIELD WIRING

- A. Install field wiring to complete the electricity metering installation.
 - 1. Transformer-rated meter:
 - a. Current transformer wiring shall be #12 AWG minimum size. Where distance to meter exceeds 22 ft, increase wire size to #10 AWG to reduce the burden on the metering circuit.
 - b. Potential wiring shall be #14 AWG.
 - c. Color coding: Same for current and potential wiring. A phase - black; B phase - red; C phase - blue; Neutral - white; Ground - green. Identify all wiring with plastic sleeve wire markers. Cloth markers are not acceptable.
 - d. Neatly train and lace wiring for metering installation within pad-mounted transformer compartment and meter socket enclosure using nylon cable ties.
 - 2. Transformer-rated meter:
 - a. Field wiring for building automation system (BAS) connection to solid-state electricity meter:
 - 1) Conduit: Install a 3/4" conduit routed underground from meter to BAS panel in the building; terminate conduit within 12" of BAS panel.
 - 2) Communications Wiring: In the 3/4" conduit, install a 3-conductor communications cable as recommended by meter manufacturer. Connect one end to cable lead from meter KYZ pulse initiator module. Leave 4 ft excess cable coiled at opposite end for connection to BAS panel.

3.5 CONNECTIONS

- A. Ground metering equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Connect power and control wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- C. Bond meter socket enclosure to grounding facilities as required. Grounding equipment per UL 467 requirements.

3.6 FIELD QUALITY CONTROL

- A. Test continuity of each circuit.
- B. Test metering equipment per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests.
- C. Interpret test results in writing and submit to Owner's Representative.
- D. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.
 - 1. Connect a load of known kilowatt rating, 1.5 hp minimum, to a circuit supplied by metered feeder.
 - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 - 3. Run test load continuously for 8 h, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
 - 4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
 - 5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.
- E. Inspect modular meter center for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.
- F. Verify that correct multiplier is indicated on face of meter.
- G. Verify that current transformer secondary circuits are intact.
- H. Inspect indicating devices for proper operation.

3.7 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer- supplied paint kit. Leave remaining paint with Owner's Representative.

3.8 ADJUSTING

- A. Adjustment and programming of metering equipment: By factory-authorized representative.
- B. Compare meter display readings with readings taken with clamp on ammeter and hand-held volt- meter.
- C. Make adjustments as necessary.

3.9 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.10 DEMONSTRATION

- A. Provide training session by manufacturer for up to 8 h at a job location, to train the Owner's personnel in the operation and maintenance of metering equipment.

END OF SECTION 26 27 13

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- B. Section 26 05 53 - Electrical Systems Identification

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes general-use snap switches, wall-box dimmers, fan speed controls, receptacles, hazardous (classified) location receptacles, pendant cord-connector devices, cord and plug sets and device cover plates.

1.4 REFERENCE STANDARDS

- A. IEEE C62.41.2 - Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits
- B. IEEE C62.45 - Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits
- C. NECA 1 - Good Workmanship in Electrical Contracting
- D. NFPA 70 - National Electrical Code
- E. NFPA 99 -Health Care Facilities
- F. NEMA FB 11 - Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations
- G. NEMA WD-1 - General Color Requirements for Wiring Devices
- H. NEMA WD-6 - Wiring Devices - Dimensional Requirements

- I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- J. UL 20 - General-Use Snap Switches
- K. UL 498 - Attachment Plugs and Receptacles
- L. UL 943 - Ground-Fault Circuit-Interrupters
- M. UL 1010 - Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations
- N. UL 1436 - Outlet Circuit Testers and Similar Indicating Devices
- O. UL 1449 - Transient Voltage Surge Suppressors
- P. UL 1472 - Solid-State Dimming Controls
- Q. UL 1917 - Solid-State Fan Speed Controls

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- F. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations and ratings of wiring devices.
 - 2. Operation and Maintenance Data:
 - a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
 - b. Include source and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

- A. Obtain wiring devices from one source and by single manufacturer.
- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.
- B. Manufacturer shall provide standard 1-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

- A. Extra Materials: Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cooper Wiring Devices; a division of Cooper Industries, Inc.
- B. Hubbell Incorporated; Wiring Device-Kellems
- C. Leviton Manufacturing Company, Inc.
- D. Pass & Seymour/Legrand; Wiring Devices & Accessories
- E. Or equal

2.2 GENERAL-USE SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches: Heavy-duty (specification grade); back and side wired; flush or surface mounting; Body and Handle: thermoplastic with rocker handle; for connection to copper or copper-clad conductors:
 - 1. Ratings:
 - a. Voltage: 120-277V, AC
 - b. Current: 20 A
 - 2. Single pole
 - 3. Double pole
 - 4. Three-way
 - 5. Four-way
 - 6. Locator Light: Lighted handle type switch (single pole with red neon-lighted handle, illuminated when switch is "OFF.")
 - 7. Pilot Light: Indicator light switch (single pole with red neon-lighted handle, illuminated when switch is "ON.")
 - 8. Locking Type: Designed to prevent tampering and unauthorized switching.
 - 9. Key-Operated: Single pole, with factory-supplied key in lieu of switch handle.
 - 10. Single-Pole, Double-Throw, Momentary Contact, Center-Off: For use with mechanically held lighting contactors.
 - 11. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
 - 12. Pendant and Through-cord: For field installation on flexible cord and provided with one "ON" and one "OFF" position.
 - 13. Weatherproof: Toggle switch.
- C. Wiring devices will accept stranded wire without the use of a wire prep device (stake on or similar).

2.3 FAN SPEED CONTROLS

- A. Comply with UL 1917
- B. Modular, 120V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
 - 1. Continuously adjustable slider, 5A.

2.4 RECEPTACLES

- A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

- B. Receptacles: 125 V, 20A, heavy-duty (specification grade); back and side wired; flush or surface mounted; straight blade; 2 pole, 3 wire grounding; thermoplastic body; duplex as indicated on drawings.
 - 1. Ground Fault Circuit Interrupter (GFCI):
 - a. Additional compliance with UL 943 Class A.
 - b. Leakage current trip level: 4 to 6 mA.
 - c. Trip time: .025 seconds nominal.
 - d. Non-feed through type
 - e. Reverse line-load function to prevent GFCI from functioning if wired incorrectly.
 - f. Indicator Light: Lighted when device is tripped.
 - 2. Twist-locking:
 - a. NEMA WD 6 configuration as indicated on drawings.
 - 3. Dedicated: Labeled "Dedicated."
 - 4. Plug-Tail type devices are permissible where an angled connector is use and connector conductors have 6" of slack before splice into circuit.
 - 5. Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.
- C. Wiring devices will accept stranded wire without the use of a wire prep device (stake on or similar).

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

- A. Comply with NEMA FB 11 and UL 1010
- B. Manufacturers:
 - 1. Cooper Crouse-Hinds
 - 2. EGS/Appleton Electric
 - 3. Killark; a division of Hubbell, Inc.
 - 4. Or equal

2.6 DEVICE COVER PLATES

- A. Single and combination types to match corresponding wiring devices:
 - 1. Attachment: Metal screws with head color to match plate finish.
 - 2. Material for Finished Spaces: Coordinate with Owner's Representative.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Thermoplastic with while-in-use hinged cover and listed and labeled for use in "wet locations."
- B. Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with weatherproof while-in-use hinged cover.

- C. Lockable Cover:
 - 1. Hinged steel cover with cylinder lock.
 - 2. Keyed all the same.

2.7 FINISHES

- A. Color:
 - 1. Switch handles, receptacle faceplates, and device cover plates: Coordinate with Owner's Representative except as follows:
 - a. Switch handles and receptacle faceplates connected to Emergency or Standby Power System: Red; labeled "Emergency."
 - b. UPS Receptacles: Gray

PART 3 - EXECUTION

3.1 COORDINATION

- A. Special Purpose Receptacles: Coordinate final selections of NEMA configuration (locking, straight, blade, etc.) with configuration of plug on utilization equipment.
- B. Receptacles for Owner-furnished equipment and equipment furnished under other divisions of specifications: Match plug configurations.
- C. Cord and Plug Sets: Match equipment requirements.
- D. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the device cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.

3.2 EXAMINATION

- A. Verify location of wiring devices with architectural interior elevation drawings, prior to rough-in.
- B. Verify outlet boxes are installed at proper height.

- C. Verify wall openings are neatly cut and completely covered by wall plates.
- D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

- A. Clean debris from outlet boxes.

3.4 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise scheduled or indicated on drawings. Indicated dimensions are to center of device.
- B. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Do not place bare stranded conductors directly under device screws. Use crimp on fork terminals for device terminations.
- C. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or show signs of installation prior to completion of building finishing operations.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6" in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than #12 AWG are installed on 15A or 20A circuits, splice #12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
 10. Install devices plumb, level with finished surfaces and free from blemishes.
 11. Install lighting switches vertically on latch side of door within 6" of frame edge.
 12. Install devices above counters, 2" to the bottom of device above countertop or backsplash.
 13. Install all devices at same height above any one counter or fixed cabinet.
 14. Install special purpose receptacles and switches according to shop and rough-in drawings furnished by trade(s) producing such equipment. Verify locations prior to rough-in.
 15. Install weatherproof GFCI receptacles:
 - a. Within 25'-0" of roof-mounted mechanical equipment
 - b. Outdoors
 - c. As indicated on drawings
 16. Group adjacent switches under single, multi-gang wall plates.
 17. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Ground per requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- D. Installation Orientations:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
 2. Install switches with handle operating vertically, with "ON" position up.
 3. Unless otherwise indicated or where space problem occurs, mount devices flush, with long dimension vertical.
- E. Device Cover Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- F. Arrangement of Devices:
1. Unless otherwise indicated or where space problem occurs, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

3.5 IDENTIFICATION

- A. Comply with Section 26 05 53 - Electrical Systems Identification.
1. Switches and Receptacles: No engraved cover plates shall be used. Provide engraved legends that are glued to standard plates per the identification standard. Include panel and circuit number only. Example: LA-12

- a. Receptacles: Label shall indicate receptacle voltage, phase, and amperage for receptacles other than 20A, 120 V, at top of cover plate, and panel and circuit number at bottom of cover plate.
- b. Switches: Label shall indicate switch voltage, phase, and amperage at top of cover plate, and panel, circuit number and switch designation at bottom of cover plate.
2. Engrave cover plates on all Owner-furnished equipment and equipment furnished under other divisions of these specifications with panelboard, circuit number and "emergency" (where applicable) as specified in this section. This includes headwalls, gas columns and booms, patient consoles, medical rail systems, custom casework with electrical devices, etc.

3.6 FIELD QUALITY CONTROL

- A. Inspect wiring devices for defects.
- B. Operate wall switches with circuits energized and verify proper operation.
- C. Verify receptacle device is energized.
- D. Perform tests and prepare test reports:
 1. Test receptacle devices for proper polarity:
 - a. Test every receptacle with receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.
 2. Test each GFCI receptacle device for proper operation:
 - a. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. "TEST" button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power with 5/1000 A within 1/40 second and retest.
 3. Test Instruments: Use instruments that comply with UL 1436.
 4. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- E. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 V to 132 V.
 2. Percent Voltage Drop under 15A Load: A value of 5% or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- F. Test straight blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.
- G. Operational Tests: Demonstrate the operation of each switch with the systems fully energized and operating. Each switch shall be demonstrated three times.
- H. Interpret test results in writing and submit to Owner's Representative.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

- A. Remove excess plaster from interior of outlet boxes.
- B. Clean devices and cover plates after painting is complete. Replace stained or improperly painted devices and cover plates.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 73 - Power System Studies
- B. Section 26 24 13 - Switchboards
- C. Section 26 24 16.16 - Distribution Panelboards
- D. Section 26 28 16 - Enclosed Switches and Circuit Breakers
- E. Section 26 29 13 - Enclosed Controllers

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and section under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes nonrenewable cartridge fuses, rated 600V and less, for use in low-voltage power distribution system and spare fuse cabinet.

1.4 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses
- B. UL 248-1 - Low Voltage Fuses - Part 1: General Requirements
- C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses
- D. UL 248-5 - Low-Voltage Fuses - Part 5: Class G Fuses
- E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses
- F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses
- G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses
- H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses

- I. UL 512 - Fuseholders

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit the following for each fuse type and size indicated:
 - a. Manufacturer's technical data on features, performance, electrical characteristics, ratings, and dimensions.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Let-through current curves for fuses with current-limiting characteristics.
 - d. Fuse size for each elevator disconnect switch.
- B. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual class, size, and location of fuses.

1.6 QUALITY ASSURANCE

- A. Obtain fuses from one source and by single manufacturer.
- B. Comply with NFPA 70 for components and installation.

1.7 MAINTENANCE

- A. Extra Materials:
 - 1. Furnish to the Owner's Representative a quantity of spare fuses equal to 25% of the total quantity of each fuse class and size installed, minimum of 3 of each fuse class and size.
 - 2. Furnish 2 fuse pullers for each size fuse.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cooper Bussmann
- B. Mersen
- C. Littelfuse
- D. Edison Fusegear
- E. Or equal

2.2 CARTRIDGE FUSES

- A. NEMA FU 1, UL 248-1.
- B. Characteristics: nonrenewable current-limiting cartridge fuse; current rating and class, as specified or indicated, and voltage rating consistent with circuit voltage.
- C. Miscellaneous data:

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-4	CC	600	0-30	200,000
248-8	J	600	0-600	200,000
248-10	L	600	601-6000	200,000
248-12	RK1	250 or 600	0-600	200,000
248-12	RK5	250 or 600	0-600	200,000

2.3 FUSEBLOCKS

- A. UL 512
- B. Thermoplastic base with UL flammability 94VO
- C. Clip reinforcing springs - 100A and above
- D. 200,000 A RMS Sym withstand rating
- E. Copper or aluminum connections

2.4 TOUCH SAFE FUSEHOLDERS

- A. UL 512
- B. Thermoplastic base with UL flammability 94VO
- C. Cover over fuses
- D. Neon indicator lamp: "ON" when fuse opens

2.5 SPARE FUSE CABINET

- A. Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified with 10% capacity minimum.
- B. Doors shall be hinged, with hasp for Owner's padlock.

- C. Finish shall be gray enamel.
- D. Cabinet shall have nameplate engraved "Spare Fuses" in 1/2" letters on door.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

3.2 INSTALLATION

- A. Verify proper fuse locations, sizes, and characteristics.
- B. Install fuses in fusible devices (specified in Sections 26 23 00 - Low-Voltage Switchgear, 26 24 13 - Switchboards, 26 24 16.13 - Lighting and Appliance Panelboards, 26 24 16.16 - Distribution Panelboards, 26 24 19 - Motor Control Centers, 26 28 16 - Enclosed Switches and Circuit Breakers, and 26 29 13 - Enclosed Controllers) at job site.
- C. Arrange fuses so manufacturer, class, and size are readable without removing fuse.
- D. Install typewritten labels on inside door of each fused device, indicating fuse replacement information.
- E. Install spare fuse cabinet as directed by Cal Poly.

3.3 APPLICATION

- A. Motor Branch Circuits: Class RK5.
- B. Other Branch Circuits: Class CC, Class J, Class RK1, Class RK5.

3.4 CLEANING

- A. Clean fuses and tighten connections prior to energizing of equipment.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems
- E. Section 26 05 53 - Electrical Systems Identification
- F. Section 26 05 73 - Power System Studies
- G. Section 26 08 12 - Power Distribution Acceptance Tests
- H. Section 26 28 13 - Fuses

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.4 REFERENCE STANDARDS

- A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting
- B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures
- C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- D. NFPA 70 - National Electrical Code

- E. UL 98 - Enclosed and Dead Front Switches
- F. UL 486A - 468B - Wire Connectors
- G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
- H. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, fuse clip features, terminal lugs and all accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.
- B. Manufacturer's Installation Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Test Reports:
 - 1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
- D. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of disconnect switches and ratings of installed fuses.
 - b. Record actual locations and continuous current ratings of enclosed circuit breakers.
 - 2. Operation and Maintenance Data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
 - b. Include spare parts data listing, source, and current prices of replacement parts and supplies.
 - c. Include Manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.6 QUALITY ASSURANCE

- A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.

- B. Regulatory Requirements:
 - 1. Comply with NFPA 70 for components and installation.
 - 2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

- C. Certifications:
 - 1. Furnish Owner's Representative with Manufacturer's Seismic Qualification Certification: Submit certification that disconnect switches and enclosed circuit breakers, accessories, and components will remain internally intact to withstand seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems. Include the following:
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. Furnish Owner's Representative with Installation Seismic Qualification Certification: Submit certification that disconnect switches and enclosed circuit breakers, accessories, and components will remain in place without separation of any parts when subjected to the seismic forces defined in Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems and will be fully operational after the seismic event. Include the following:
 - a. Detailed description of disconnect switches and enclosed circuit breakers anchorage devices and seismic restraints on which the certification is based and their installation requirements.
 - b. Certification shall bear the seal and signature of an Engineer registered and licensed in the State of California.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

- B. Comply with manufacturer's written instructions.

1.8 WARRANTY

- A. Refer to Division 01 and Section 26 00 00 - General Electrical Requirements for general warranty requirements.

- B. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Square D
- B. Cutler-Hammer
- C. Or equal

2.2 DISCONNECT SWITCHES

- A. NEMA KS 1, UL 98
- B. Load interrupter enclosed knife switch, heavy-duty type.
- C. Fusible type as indicated.
- D. Switch Interiors:
 - 1. Switch blades that are visible in "OFF" position when switch door is open.
 - 2. Plated current carrying parts.
 - 3. Removable arc suppressors to permit easy access to line side lugs.
- E. Switch Mechanism:
 - 1. Quick-make, quick-break, with visible blades and externally operable handle.
 - 2. Lockable only in "OFF" position and accept three industrial type, heavy-duty padlocks.
 - 3. Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open.
 - 4. Defeater mechanism to bypass interlock.
 - 5. Operating handle integral part of enclosure.
 - 6. Handle to physically indicate "ON" and "OFF" position.
- F. Ratings:
 - 1. Ampacity as indicated on drawings.
 - 2. Horsepower rated.
- G. Fusible Switches:
 - 1. Rejection clips for Class R fuses specified.
 - 2. Provisions for Class J or Class L fuses, as applicable.
 - 3. Fuses: Per requirements in Section 26 28 13 - Fuses.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. NEMA AB 1, UL 489.
- B. Enclosed molded-case circuit breakers:
 - 1. Tripped indication clearly shown on breaker handle taking position between "ON" and "OFF."
 - 2. 100A frame size and below: thermal-magnetic trip.
 - 3. 100A frame size and above: electronic (solid-state microprocessor-based) trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.
 - 4. Locks on trip handles where indicated.
 - 5. Molded-case switch in lieu of thermal-magnetic molded-case circuit breaker, where indicated.
 - 6. Shunt trip, where indicated.
- C. Breaker Mechanism:
 - 1. Quick-make, quick-break.
- D. Ratings:
 - 1. Ampacity as indicated on drawings.
 - 2. Listed as Type HACR for air conditioning equipment circuits.
 - 3. Listed as Type SWD for lighting circuits.

2.4 LUGS

- A. Front removable lugs.
- B. Labeled for 75°C copper and aluminum conductors.
- C. Multiple lugs to match number of conductors per phase.
- D. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

2.5 ACCESSORIES:

- A. Solid neutral assembly, where required.
- B. Equipment ground kit.
- C. Blown fuse indicators on fused disconnect switches.

- D. Factory installed fuse puller on fused disconnect switches.
- E. One set of normally open (NO) auxiliary contacts, where disconnect switch is installed at a remote motor served by variable frequency drive (VFD).

2.6 ENCLOSURES

- A. NEMA KS 1, NEMA AB 1, UL 98, UL 489, as applicable.
- B. NEMA Type 1, Type 3R (outdoor locations) enclosure.
- C. Code-gauge galvanized steel.
- D. Manufacturer's standard gray enamel finish over prime coat.
- E. Surface-mounted.

2.7 SHORT CIRCUIT CURRENT RATING

- A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

- A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.
- B. Verify that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

- A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.
- C. Notify Owner's Representative of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

- A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.
- B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.
- C. Disconnect switches and enclosed circuit breakers mounting and seismic restraints:
 - 1. Install disconnect switches and enclosed circuit breakers anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State of California, and to comply with Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems for seismic criteria.
 - 2. Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
 - 3. Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Install two rows of steel slotted channel, with a minimum of four attachment points, for each disconnect switch and enclosed circuit breaker.
 - 5. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.
- D. Do not support disconnect switches and/or enclosed circuit breakers by raceway.
- E. Install top disconnect switch and/or enclosed circuit breaker handle a minimum of 3'-6" and maximum of 6'-6" above finished floor.
- F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.
- G. Install engraved plastic nameplates under provisions of Section 26 05 53 - Electrical Systems Identification. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.
 - 1. Include switch and/or enclosed circuit breaker name, amperage, voltage, phase, and number of wires.
- H. Install fuses in fusible switches at job site per requirements in Section 26 28 13 - Fuses.

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.
- B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.
- C. Test disconnect switches and/or enclosed circuit breakers per requirements in Sections 26 08 12 - Power Distribution Acceptance Tests and 26 08 13 - Power Distribution Acceptance Test Tables.
- D. Interpret test results in writing and submit to Owner's Representative.

3.6 REPAINTING

- A. Remove paint splatters and other marks from surface of equipment.
- B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer- supplied paint kit. Leave remaining paint with Owner's Representative.

3.7 ADJUSTING

- A. Circuit Breakers: Set field-adjustable trip settings or change the trip settings recommended by the overcurrent protective device coordination study per Section 26 05 73 - Power System Studies.

3.8 CLEANING

- A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 26 28 16

SECTION 26 41 13 - LIGHTING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Section includes lightning protection systems consisting of air terminals, roof conductors, bonding conductors, down conductors, fastener connections, and grounding.

1.4 REFERENCE STANDARDS

- A. ANSI/NEMA GR1 - Grounding Rod Electrodes and Ground Rod Electrode Couplings
- B. NFPA 70 - National Electrical Code
- C. NFPA 780 - Standard for the Installation of Lightning Protection Systems
- D. UL 467 - Grounding and Bonding Equipment
- E. UL 96 - Lightning Protection Components
- F. UL 96A - Installation Requirements for Lightning Protection Systems

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit manufacturer's descriptive and technical literature and catalog cuts.
- B. Shop Drawings:

1. Submit installation shop drawings for the overall lightning protection system. Include physical layout of the equipment, mounting details, and relationship to other parts of the work.
 2. Submit detail drawings for each major component.
 3. Submit location, size, and material of grounding electrodes, and connection type.
 4. Submit roof adhesive data for air terminals mounted on single-ply roofing.
- C. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply roofing material.
- D. Copy of Owner's UL Master Label Certificate.
- E. Manufacturer's Installation Instructions:
1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.
- F. Closeout Submittals:
1. Project record documents:
 - a. Record active location of lightning protection system components.
 2. Operation and maintenance data:
 - a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventative maintenance instructions.

1.6 QUALITY ASSURANCE

- A. Qualifications:
1. Lightning protection system materials:
 - a. Consists of standard products by a manufacturer regularly engaged in production of lightning protection systems.
 - b. UL Listed
 2. Lightning protection system installer: UL Listed.
- B. Regulatory Requirements:
1. Lightning protection system: Comply with NFPA 780, UL 96, and UL 96A.
- C. Certifications:
1. Furnish Owner's Representative with UL Master Label Certificate upon completion of installation providing proof that the lightning protection system is in compliance with UL 96 and UL 96A standards.

1.7 SEQUENCING

- A. Coordinate installation of lightning protection with installation of other building systems and components, including supporting structures and building materials, metal bodies requiring bonding to lightning protection components, exterior and interior building finishes, and building roofing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Thompson Lightning Protection Company
- B. Harger Lightning Protection, Inc.
- C. Heary Brothers Lightning Protection Company, Inc.
- D. National Lightning Protection Corporation
- E. Erico International Corporation
- F. Or Equal

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. NFPA 780, UL 96.
- B. Materials: Air terminals, main and cross-run roof conductors, bonding and down conductors, conductor fasteners, air terminal supports, chimney bands, clips, and connections: Class I:
 - 1. Air terminals: Solid-type with a safety tip, 10" in height minimum, above the object to be protected when spaced at intervals not exceeding 20 ft, with mounting base.
- C. ANSI/NEMA GR1 Grounding Electrodes: 3/4" x 10 ft long copper-clad steel ground rod.
- D. Concrete-Encased Electrodes: As shown on drawings.
- E. Solid Copper Ground Plate (if called for on drawings): Where shallow or rocky top soil conditions preclude the use of driven ground rods. This ground plate is 18" x 18" x 20 gauge thick (0.032" minimum) and comes complete with two premium die cast bolt pressure type cable connections for cables through #3/0.
- F. Ground Ring Electrode: As shown on drawings.

- G. Ground Connectors: Conform to UL 96
 - 1. Bronze of the clamp type and bronze clamp accessories.
 - 2. Provide in accordance with the requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems.

- H. Galvanic Compatibility of Materials:
 - 1. Air terminals, conductors, fasteners, and connectors shall be galvanically compatible with surfaces they are mounted to.
 - 2. Copper materials in all locations except where the use of aluminum materials is necessary for galvanic compatibility.
 - 3. Aluminum materials on copper roofs are not acceptable.
 - 4. Aluminum materials where mounted on aluminum roofing, siding, or other aluminum surfaces.

- I. Bimetallic fittings when joining metals that are not galvanically compatible.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lighting protection to comply with UL 96A, NFPA 70, and NFPA 780. Conform to the most stringent requirement in NFPA 780.

- B. Bond exterior metals including flashing, roof drains, vent stacks, fans, water pipes, metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical and mechanical equipment on roof to lightning protection system.

- C. Bond lower end of exhaust ducts, vent stacks, etc., passing through roof.

- D. Run bonding jumpers continuously horizontally or down from point of bond to point of connection to main conductor.

- E. Make down conductors electrically continuous, with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Protect down conductors, where necessary, to prevent physical damage or displacement to the conductor. Use PVC Schedule 40 conduits. Provide conduits in accordance with requirements in Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 1. Provide down conductors for every 100 feet of building perimeter.
 - 2. For structural steel construction, utilize steel columns (bond top and bottom) in lieu of down lead conductors - every other column and not to exceed an average of 60 foot spacing.

- F. Conceal system conductors and interior conductors.

- G. Conceal conductors from normal view from exterior locations at grade within 200 ft of building.
- H. Notify Owner's Representative at least 48 H before concealing lightning protection system components.
- I. Below-grade or concealed cable connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.
- J. Exposed cable connections: Use approved mechanical connections.
- K. Air terminals mounted on single-ply roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. For roofing work, refer to Division 07 - Thermal and Moisture Protection.
- L. Attach each down conductor to the grounding electrode by exothermic welding.
- M. Provide grounding electrodes with top 2 ft below finished grade.
- N. Ramps and covered passageways shall be protected by the lightning protection system.
- O. For construction utilizing post tensioning systems to secure precast concrete sections, do not use the post tension rods as down conductors. Bond tension rods to the lightning protection and grounding system - follow recommendations of the post tension rod manufacturer.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the present of moisture, unless moisture is permanently excluded from the junction of such materials.
- B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. Apply for inspection by Underwriters Laboratories, Inc. (UL) to obtain UL Master Label Certificate.
- B. Verify that lightning protection surge arrestor devices are installed on all incoming power and communications lines, in order to obtain UL Master label Certificate.

- C. Test grounding system to ensure continuity prior to backfilling and paving: Check that resistance to earth does not exceed 25 ohms, measured by "Fall-of-Potential" method.
- D. Make resistance measurements in dry weather not earlier than 48 H after rainfall.
- E. Make visual inspection to verify that there are no loose connections that may result in high resistance joints, and conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.
- F. Photograph all concealed components of the system such as grounding electrode connections, down conductors and connections to reinforcing steel. Identify locations where each photograph was taken.

END OF SECTION 26 41 13

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 00 00 - General Electrical Requirements
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 23 00 - Low-Voltage Switchgear
- D. Section 26 24 13 - Switchboards
- E. Section 26 24 16.13 - Lighting and Appliance Panelboards
- F. Section 26 24 16.16 - Distribution Panelboards
- G. Section 26 27 26 - Wiring Devices

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

- A. Provide Type 1 Surge Protective Devices (SPD) for the protection of AC electrical circuits formerly known as Transient Voltage Surge Suppression (TVSS) System. Provide high energy surge current diversion and be suitable for application in Type 1 environments.
- B. Modes of Protection:
 - 1. Line to Ground, Line to Neutral and Neutral to Ground for services with a neutral.
 - 2. For Services without a neutral, Line to Line and Line to Ground.
- C. Provide common and normal modes of protection.

1.4 REFERENCE STANDARDS

- A. ANSI/UL 1449 Surge Protective Devices Third Edition or Newer

- B. IEEE 587
- C. FIPS PUB 94
- D. IEEE C62.11 - Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (> 1 kV)
- E. IEEE C62.41.1 Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
- F. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- G. IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low- Voltage (1000 V and less) AC Power Circuits
- H. IEEE C62.62 IEEE Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000V and less) AC Power Circuits
- I. National Electrical Code - Article 285
- J. NEMA LA 1 - Surge Arresters
- K. National Fire Protection Association - NFPA 20, 70, 75, and 780
- L. UL 96A Installation Requirements for Lightning Protection Systems

1.5 SUBMITTALS

- A. Submit Shop Drawings for equipment provided under this Section.
- B. Submit shop drawings and product information for approval and final documentation in quantities listed according to Conditions of the Contract. Identify customer name, customer location, and customer order number.
- C. Submit ANSI/UL 1449 Listing documentation to indicate the following:
 - 1. Short Circuit Current Rating (SCCR)
 - 2. Voltage Protection Ratings (VPRs) for all modes
 - 3. Maximum Continuous Operating Voltage rating (MCOV)
 - 4. Nominal Discharge Current rating (I-n)
 - 5. Type 1 device

6. VPR, MCOV, I-n, and Type 1 information is posted at www.UL.com under Certifications; search using UL Category Code: VZCA. SCCRs are posted in manufacturer's published documentation.
 7. UL data and visual inspection takes precedence over manufacturer's published documentation.
- D. Provide shop drawings including manufacturer installation instruction manual and line drawings detailing dimensions and weight of enclosure, internal wiring diagram illustrating all modes of protection in each type of SPD required, wiring diagram showing field connections, and manufacturer's recommended wire and breaker sizes (if required).
- E. Upon request, modules using encapsulation shall be presented without encapsulation for visual inspection, proprietary technology included. MOV type and quantity shall reflect kA ratings on cutsheets, verification of diagnostic monitoring, thermal and overcurrent protection, etc.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Acceptable manufacturers:
1. Advanced Protection Technologies, Inc. (APT)
 2. Thomas & Betts; Current Technology
 3. LEA International
 4. Emerson; Liebert Corporation
 5. Mersen
 6. Erico
 7. Or equal

2.2 PERFORMANCE CHARACTERISTICS

- A. SPD shall bear the UL Mark and shall be Listed to Third Edition of ANSI/UL 1449. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet intent of specification.
- B. Post SPD and performance parameters at www.UL.com under Category Code: VZCA. Products or parameter without posting at UL.com are not approved.
- C. Minimum surge current capacity for Service Entrance units based on 8 x 20 microsecond current waveform:
1. 200,000 A between each phase for line-to-line mode
 2. 200,000 A each phase for line-to-ground mode

3. 200,000 A each phase for line-to-neutral mode
 4. 200,000 A for neutral-to-ground mode
- D. Minimum surge current capacity for panelboard units based on 8 x 20 microsecond current waveform:
1. 80,000 A between each phase for line-to-line mode
 2. 80,000 A each phase for line-to-ground mode
 3. 80,000 A each phase for line-to-neutral mode
 4. 80,000 A for neutral-to-ground mode
- E. Sequential Surge Current Survivability:
1. 1,000 sequential category surges without failure.
- F. Current Rating:
1. Rated for continuous current and AIC rating of equipment protected.
 2. Mark SPD Short-Circuit Current Rating on the SPD label.

2.3 OPERATING CONDITIONS

- A. Temperature range: -40°F to 122°F
- B. Relative humidity range: 0 to 95%, non-condensing
- C. Audible noise level: > 40 dBA at 5 ft
- D. SPD Surface Temperature: less than 131°F

2.4 FABRICATION

- A. SPD Modules:
 1. UL Labeled as Type 1 (verifiable at www.UL.com), intended for use without need for external or supplemental overcurrent controls. Protect suppression component of every mode, including N-G, by internal overcurrent and thermal overtemperature controls. SPDs relying on external or supplementary installed safety disconnects do not meet intent of specification.
 2. UL Labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Mater label and NFPA 780.
 3. Suppression components: Heavy-duty MOVs, selenium cells, or combination of both.
 4. Provide surge current diversion paths for all modes of protection: L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.
 5. Provide service entrance SPD audible diagnostic monitoring by way of audible alarm.

6. Provide service entrance SPD with 1 set of NO/NC dry contacts for alarm conditions.
7. Provide visual LED diagnostics including a minimum of 1 green LED indicator per phase, and 1 red service LED. Include an audible alarm with on/off silence function and diagnostic test function (excluding branch).
8. If a dedicated breaker for the SPD is not provided in the switchgear, switchboard, or panelboard include an integral UL Recognized disconnect switch. Dedicated breaker to serve as a means of disconnect for distribution SPDs.
9. Meet or exceed the following criteria:
 - a. ANSI/UL 1449 Listed Voltage Protection Ratings (VPRs) for 6kV 3000A testing as follows:

VOLTAGE	L-N L-G N-G	L-L
208Y/120V	≤800V	≤1200V
480Y/277V	≤1200V	≤2000V

10. ANSI/UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	15%	150V
480Y/277	15%	350V

11. Provide serviceable, replaceable modules (excluding Branch).
 12. Provide warranty for a period of 10 years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.
 13. Provide SPD with digital surge event counter with capacitor backup.
- B. Service Entrance:
1. Install 1 primary suppressor external to the service entrance in accordance with manufacturer instructions.
 2. Install SPD on line or load side.
 3. Bond SPD ground to service entrance ground.
- C. Distribution Panelboards:
1. Install 1 suppressor external to each designated distribution panelboard.
 2. Install surge suppression device in accordance with manufacturer instructions.
- D. SPD Low-Impedance Interconnect Cable:
1. Provide low-impedance cable specifically listed for SPD installations.

2. Low impedance approximately 25% of conventional pipe and wire for improved clamping voltage.

PART 3 - EXECUTION

3.1 APPLICATION OF SPD

- A. Provide UL approved disconnect switch at Service Entrance or Transfer Switch as a means of service disconnect if a breaker sized per manufacturer's recommendations is not available.
- B. Provide independent means of servicing disconnect at Distribution, MCC, and Branch such that the protected panel remains energized. A 30A breaker (or larger based on manufacturer's recommendations) may serve this function.
- C. Provide SPD for each panel, distribution panel associated with the Emergency branch of power.

3.2 INSTALLATION

- A. Install per manufacturer's recommended practices.
- B. Provide short and straight conductors not exceeding 3 ft in length. Manufacturer-approved cables may be used that allow conductor length to extend beyond 3 ft in length without affecting capability of unit.
- C. Input conductors twisted together to reduce inductance.
- D. Avoid 90-degree bends in cable.

3.3 QUALITY ASSURANCE

- A. Factory test system before shipment. Include quality control check, "Hi-Pot" tests at 2 times rated voltage plus 1,000 V, ground leakage tests, and calibration.
- B. Manufacturer Qualifications: Engage a firm with at least 5 yrs experience in manufacturing surge protective devices.
- C. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 yrs. When requested by Owner's Representative, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with requirement.

- D. Provide SPD compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

3.4 FIELD QUALITY CONTROL

- A. Inspections before SPD startup:
 - 1. Visual Inspection:
 - a. Verify installation per drawings.
 - b. Verify phase, neutral, and ground conductors are properly sized and configured.
 - 2. Mechanical Inspection:
 - a. Check connections for tightness.
 - b. Check terminal screws, nuts and/or connectors for tightness.
 - 3. Electrical Inspection:
 - a. Confirm input voltage.
 - b. Confirm phase, neutral and ground connections are proper.

3.5 WARRANTY

- A. Provide 10-year manufacturer warranty.

END OF SECTION 26 43 00

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SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.1 RELATED WORK

- A. Section 26 00 00 - General Electrical Requirements
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- C. Section 26 05 19.16 - Manufactured Wiring Systems
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- E. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- F. Section 26 09 23 - Lighting Control Devices

1.2 REFERENCE

- A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF WORK

- A. Provide complete and fully operational lighting system per Contract Drawings and Specifications.
- B. Luminaires shall be provided complete with necessary accessories for proper installation.
- C. Catalog numbers shown in luminaire schedule are basic luminaire types. Additional features, accessories and options specified, scheduled or necessary for proper installation shall be included.
- D. Provide lamps for luminaires as recommended by luminaire manufacturer, unless noted otherwise.
- E. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.

- F. Work includes final aiming and focusing of luminaires under direction of the Owner's Representative.
- G. All lighting is to use LED sources. The use of incandescent, HID, Florescent, etc is generally not permitted but will be evaluated on a case by case basis. Contact University representatives for approval of any deviation from use of LED.

1.4 REFERENCE STANDARDS

- A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)
- B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)
- C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)
- D. NECA 503 - Standard for Installing Fiber Optic Lighting Systems
- E. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility
- F. UL 496 - Lampholders
- G. UL 773 - Plug-in Photocontrols for use with area lighting
- H. UL 924 - Emergency Lighting and Power Equipment
- I. UL 1574 - Track Lighting
- J. UL 1598 - Luminaires
- K. UL 1838 - Low Voltage Landscape Lighting Systems
- L. UL 2108 - Low Voltage Lighting Systems
- M. UL 2388 - Flexible Lighting Products
- N. UL 2562 - Pendant Cable
- O. UL 8750 - LED Light Sources for use in Lighting Products
- P. ANSI C78.377 - Chromaticity
- Q. IESNA LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- R. IESNA LM-80 - Approved Method: Testing Lumen Maintenance of LED Light Sources

- S. IESNA TM21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources including Addendum A

1.5 QUALITY ASSURANCE

- A. Luminaire and accessory components shall be constructed of materials appropriate for their use.
- B. Luminaires, ballasts, drivers, lamps and other components shall meet the requirements of all applicable State and Municipal codes and energy codes.
- C. Provide luminaires listed and labeled by UL or other testing lab acceptable to local jurisdiction for their indicated use and installation conditions.
- D. Contractor shall coordinate installation of lighting systems with all trades.
 - 1. Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Owner's Representative.
 - 2. Multiple Name Specification:
 - a. When multiple manufacturers are listed, Electrical Contractor shall choose which of the listed products are to be provided.
 - b. Products of the same type shall be of same manufacturer.
 - 3. Single Name Specification:
 - a. When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product with no exceptions.
 - b. Specifier has secured accurate pricing for all single name products prior to bidding and has shared this information with Architect/Owner's Representative. Contractor shall supply contractor net unit pricing for all single name products specified. Unit price shall be for equipment only and not include installation or miscellaneous electrical costs.
 - 4. Contractor shall coordinate and verify compatibility of luminaires with lighting control system.
 - a. Control protocol indicated for luminaires matches protocol of lighting control system specified. Contractor shall coordinate and verify compatibility of all dimming luminaires with control system to ensure that dimming is flicker free, continuous dimming through the dimming range noted on the luminaire schedule.
- E. Substitution requests:
 - 1. Will be evaluated prior to Bid.

2. Shall follow procedures set forth in this Section under paragraph 1.7 and in Section 01 25 00 - Substitution Procedures.
3. Shall be made not less than 10 days prior to bid date.
4. Shall include the following information indicating that the proposed substitution is of similar construction quality and assembly, lumen output and distribution, color temperature, color consistency, and controllability:
 - a. Specified and proposed manufacturer's product data sheet, noting options and features.
 - b. Provide dimensioned drawing of luminaire.
 - c. Provide photometric data in form of an electronic IES file on CD, USB or via email for use in a recognized computer lighting program.
5. Provide table-top working samples and/or mockup of specified luminaire and proposed alternate.
6. Samples shall:
 - a. Be fully operable, complete with specified lamp(s) and with functioning cord and plug ready for installation.
 - b. Remain available during construction.
 - c. Meet the requirements outlined in Section 1.8.
7. Electrical Contractor shall be responsible for all costs incurred by substitution request sample and/or mockup production and review.
8. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.
9. When requesting a substitution, Electrical Contractor shall provide unit and extended pricing for specified luminaire, unit and extended pricing for proposed alternate, and unit and extended delta savings to Owner's Representative to be realized by accepting proposed alternate. If requested, provide unit pricing for each luminaire type specified to provide a baseline comparison for substitution request.
10. Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.
11. For all luminaire types using an LED light source, provide independently tested, IESNA LM- 79 compliant photometry testing data and IESNA LM-80 Lumen Maintenance data.

1.6 Warranty

- A. Ballasts: Provide manufacturer's warranty for a period of not less than five years from the date of substantial completion. Warranty shall include parts and labor to replace defective ballasts.
- B. Exit Signs Utilizing LED lamp Technology: Provide manufacturer's warranty for a period of not less than five years from the date of substantial completion including parts and labor for full replacement of defective product.
- C. LED Luminaires: Provide Manufacturer's warranty for a period of not less than five years from the date of substantial completion or the specified warranty period greater than five years for repair or replacement of defective electrical parts, including light source and driver.

1.7 SUBMITTALS

- A. After award of Contract, submit complete list of lighting products to be furnished, with manufacturer and catalog designations, including currently quoted lead times for product delivery. Should Electrical Contractor anticipate delivery schedule of any specified product may adversely impact construction schedule, they shall bring it to the attention of Owner's Representative at this time.
- B. In addition to complying with requirements of Section 26 00 00 - General Electrical Requirements, submittals shall include the following:
 - 1. Manufacturer's product data
 - 2. Installation instructions
 - 3. Maintenance data
 - 4. Parts list for each luminaire accessory
 - 5. Photometric Data: photometric data for luminaire, including optical performance as follows:
 - a. Coefficients of utilization
 - b. Luminance table
 - c. Candela distribution data
 - d. Zonal lumens
 - e. Area and roadway luminaires shall include Isocandela Charts, IES Roadway Distribution Classification and IES BUG (Backlight - Uplight - Glare) ratings.
 - 6. Driver schedule indicating manufacturer, type, and catalog number for each luminaire
 - 7. Driver cut sheet for each driver used, referencing luminaire type(s)
 - 8. Lamp schedule indicating manufacturer, type, and catalog number for each luminaire
 - 9. Lamp cut sheet for each lamp used, referencing luminaire type(s)

10. Documentation of lamp and ballast or LED and driver compatibility
 11. Product color/finish
 - a. Where specific finish or color is not specified and options exist, submit color or finish samples to Owner's Representative for selection.
- C. Shop Drawings for equipment provided under this Section shall include the following:
1. Overall submittal drawings indicating luminaire size, mounting (including ceiling type), light source, shielding, and voltage attributes, as well as manufacturer's product data, installation instructions, maintenance data, and parts list for each luminaire.
 2. Catalog cutsheets lacking sufficient detail will not be accepted.
 3. Detailed drawings of linear pendant mounted and suspended luminaires including dimensions, support spacing, suspension type, power feed type and locations, lamp combinations, ballast/driver locations, wiring and controls configuration, luminaire joint locations and end plates. Provide canopy details that indicate coordination with the ceiling system provided.
 4. Detailed drawings for each cove and linear wall system configuration including dimensions, power feed locations, driver locations, luminaire joint locations, extension plates for end and corner sections and end plates.
 - a. For LED strip luminaires mounted in architectural coves, provide dimensioned drawings and sections and include accessory cut sheets as specified. Within coves, all luminaires are to be mounted end to end with no more than 12" unlit split evenly between ends.
 5. Detailed drawings for LED systems including LED color, color consistency, rated life, warranty, and scale plans with luminaire layout, number, type and location for drivers, and a complete bill of materials.
 6. Detailed drawings for continuous recessed or continuous surface mounted LED luminaires including dimensions, power feed locations, ballast or driver locations/quantity, luminaire joint locations, extension plates for end and corner sections and end plates as applicable.
 7. Detailed drawings for custom LED handrail systems including dimensions, power feed locations, ballast or driver locations/quantity, luminaire joint locations as applicable.
 8. For LED luminaires, submit documentation that indicates specified products have been tested, or will be tested, for compatibility with the lighting controls being procured and will perform as specified. Control devices or system shall be able to control luminaires with flicker free, continuous dimming, in range specified. Electrical Contractor, luminaire manufacturer and lighting control manufacturer shall be financially responsible for any incompatibilities.
 9. Detailed drawings for nonstandard/custom luminaires indicating dimensions, weights, method of field assembly, components, features, and accessories. Details shall be scaled to a legible size.

10. Detailed drawings for fiber optic systems including scaled plans with cable layout number and type of fiber bundles, illuminator quantity and location, and a complete bill of materials.
 11. Drawings for site lighting shall include pole data with wind loading, complete dimensions and finish, pertinent physical characteristics and accessories including mounting details, ballast/driver type and location and any specified control options.
 12. Photometric Data: Where indicated on luminaire schedule and Contract Drawings, supply complete photometric data for luminaire, including optical performance rendered by independent testing laboratory developed according to methods of the Illuminating Engineering Society of North America as follows:
 - a. Coefficients of utilization
 - b. Luminance table with data presented numerically, showing maximum luminaire luminance at shielding angles. Readings should be taken both crosswise and lengthwise in case of fluorescent luminaire or luminaire with an asymmetric distribution.
 - c. Candela distribution data, presented graphically and numerically, in 5-degree increments (5-degrees, 10-degrees, 15-degrees, etc.). Data developed for up and down quadrants normal, parallel, and at 11-1/2-degrees, 45-degrees, 67-1/2-degrees to lamps if light output is asymmetric.
 - d. Zonal lumens stated numerically in 10-degree increments (5-degrees, 15-degrees, etc.) as above.
 13. No variation from the general arrangement and details indicated on drawings shall be made on shop drawings unless required by actual conditions. All variations shall be marked on drawings submitted for approval.
- D. Provide luminaires with factory or field finish as directed by Owner's Representative. Verify final finish requirements before releasing luminaires for fabrication.
- E. Where specific finish or color is not specified and options exist, submit color or finish samples to Owner's Representative for selection. Luminaires not having color or finish acceptable to Owner's Representative shall be replaced at no additional cost.

1.8 SAMPLES

- A. Upon return of submittals, and prior to release for manufacturing, Contractor shall furnish one working sample of each luminaire for which sample requirement is noted in Luminaire Schedule.
1. All requested samples shall be furnished as specified on luminaire schedule including but not limited to: light output, correlated color temperature, distribution, lens type and finish.

- B. Shipping: Samples shall be complete with specified lamp(s) or LED module(s), cord and plug, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to Owner's Representative or as otherwise advised.
- C. Samples will not be returned, nor included in quantities listed for project.
- D. Sample must be actual working unit.
- E. All custom luminaires require a submission of material finish samples, component approval and a complete operating prototype luminaire. Prototype to be submitted prior to commencement of final luminaire fabrication and shall include specified lamps. Modifications may be required as a result of prototype review. These modifications and others that do not materially affect the cost of the luminaire shall be incorporated at no additional cost to Owner.

1.9 LUMINAIRE MOCK-UPS

- A. Upon return of submittals, and prior to release for manufacturing, Contractor shall provide mock-up on site (or at another agreed upon location) in actual architectural conditions for review by Owner's Representative for each luminaire noted in Luminaire Schedule.
- B. Provide type and quantity of luminaires as requested by Owner's Representative.
- C. Mock-up shall include working luminaires and fastening devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Luminaires:
 - 1. As shown on Luminaire Schedule
- B. LED Drivers:
 - 1. Shall be manufacturer recommended compatible driver.
 - 2. All LED drivers shall be dimming type standard unless otherwise noted. Refer to construction documents for control per application.
 - 3. Manufacturers must be compatible with lighting control system(s) provided and control luminaires from 100% to 1% light output or 100% to 10% light output per Luminaire Schedule and controls intent documents.
- C. Low Voltage Transformers:
 - 1. Q-Tran or as specified in the Luminaire Schedule

- D. LED Modules:
 - 1. Philips Lumileds, Xicato, Cree, GE, Nichia, Osram Sylvania, Bridgelux, Citizen or as specified in the Luminaire Schedule

2.2 FABRICATION AND MANUFACTURER

- A. Luminaires:
 - 1. Construction
 - a. Luminaires shall bear label indicating circuit voltage. Labels shall not be visible from normal viewing angles.
 - b. Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
 - c. Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
 - d. Surface temperatures of luminaires with ballasts or integral drivers shall not exceed 90°C in 30°C ambient.
 - e. Luminaires recessed in ceilings utilized as air handling plenums shall be certified as suitable for the purpose and conform to NEC Article 300.
 - f. Miter cuts shall be accurate, joints shall be flush and without burrs.
 - g. LED troffers with doors shall have spring-loaded door cam latches.
 - h. Luminaires shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance documented. Ballasts, low voltage transformers and drivers shall be vented per manufacturer's specifications.
 - i. Provide inscription for exit and stairway signs to conform to applicable codes.
 - j. Verify types of ceiling construction with General Contractor prior to releasing luminaires for fabrication and delivery and provide luminaires adapted to ceiling construction used.
 - k. Coordinate recessed luminaire mounting appurtenances, flanges and trims with construction of ceiling in which luminaire is to be recessed. Provide correct luminaire mounting assembly.
 - l. Luminaire frames shall be manufactured of non-ferrous metal or be suitably rust proofed after fabrication.
 - m. Recessed high intensity discharge luminaires with integral ballasts, installed indoors, shall have UL listed thermal protection integral with ballast. Exceptions are luminaires installed in suspended lay-in, grid type ceilings and which comply with UL suspended ceiling luminaire listing.
 - 2. LED Luminaires are considered a lighting system with dependent components that must be evaluated as a complete system. Each LED luminaire includes a light emitting source, provisions for heat transfer, electrical control, optical control,

mechanical support and protection, as well as aesthetic design elements. All LED luminaires shall:

- a. Be UL listed or equivalent. Where remote drivers are specified, all drivers shall also have UL listing or equivalent and comply with code requirements.
 - b. Be tested to IESNA LM-79-08 testing using absolute photometry criteria.
 - c. Be rated at > or = to 70% lumen maintenance at 50,000 hours of operation.
 - d. Be rapid cycle stress tested.
 - e. Have integral lamp modules with a minimum operating temperature of -20°C.
 - f. Have lamp modules that are capable of being easily replaced upon failure with a manufacturer provided replacement module without voiding the UL listing of the luminaire.
 - g. Have driver housings easily accessible for ease of maintenance.
 - h. Have a maximum operating temperature at LED junction to not exceed 90°C over the expected operating range of the luminaire.
 - i. Be RoHS compliant, lead and mercury free.
 - j. Have an LED operating frequency of + or - 120 Hz.
 - k. Must meet the appropriate Federal Communications Commission (FCC) requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use).
 - l. Be Class A Sound rated.
 - m. Be supplied with power supply that complies with IEEE C. 62.41-1991.
 - n. Operate at 120 or 277 volts, $\pm 10\%$.
 - o. Have reverse polarity protected at all hardwired connections and have high voltage protection in the event connections are reversed or shorted during the installation process.
3. Lenses, Reflectors and Diffusers
- a. All lenses or louvers shall be removable but held so that normal motion will not cause them to drop out.
 - b. All glass used in incandescent or LED luminaires shall be made from thermal shock resistant borosilicate glass.
 - c. Optical lenses shall be free from spherical and chromatic aberrations.
 - d. Acrylic lenses shall be 100% virgin acrylic material.
 - e. Diffuser materials shall be UV stabilized in applications exposed to sunlight.
 - f. LED troffer lenses shall be 0.125" thick, unless otherwise noted.
 - g. Alzak reflectors and louvers shall be low iridescent equivalent to Coil Anodizers. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of ten years.
 - h. Reflector cones shall not have visible lamp flashing in the cone.
4. Optics and Adjustments

- a. Lamp holders shall be suitable for the indicated lamps and shall be set such that lamps are positioned in optically correct relation to all luminaire components.
 - b. Adjustable Angle Luminaire: Luminaires with adjustment beam angle shall contain reliable angle locking devices.
5. Finishes
- a. Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.
 - b. Painted luminaires shall be painted after fabrication or "post painted."
 - c. Ferrous parts and supports shall be rust proofed after fabrication.
 - d. For weatherproof or vaportight installations, painted finishes of luminaires and accessories shall be weather resistant using proper primers or galvanized and bonderized epoxy, so that entire assembly is completely corrosion resistant for service intended and rated for an outdoor life expectancy of not less than 20 years.
6. Wiring
- a. Luminaires shall be completely wired at the factory and as required by code.
 - b. Internal wiring shall contain no splices.
 - c. Connections shall be made with insulated "wire nut" type mechanical connectors except that ballast and driver connections shall comply with NEC Article 410.
 - d. Wire for connections to lamp sockets and lamp auxiliaries shall be minimum #16 AWG luminaire wire.
 - e. Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.
 - f. Recessed incandescent luminaires shall incorporate integral thermal protection.
 - g. Incandescent luminaires shall be wired with heat resistant wire.
 - h. Recessed luminaires installed in inaccessible ceilings shall be UL listed for through wiring with the junction box accessible from the luminaire opening.
 - i. Provide dual-level switching for luminaires as indicated on luminaire schedule and/or where shown on Contract Drawings. Typically, first switch designation controls outboard lamps, and second switch designation controls inboard lamp(s), unless noted otherwise.
 - j. Provide wiring for master/ satellite luminaire configuration as indicated on luminaire schedule and/or where shown on Contract Drawings. For single lamp luminaires, provide a two-lamp ballast for two adjacent luminaires. For three-lamp luminaires, provide one two-lamp ballast for the outboard lamps in each luminaire and an additional two-lamp ballast for the center lamp in each of two adjacent luminaires.

- k. Provide wiring for tandem wired luminaires as indicated on luminaire schedule and/or where shown on Contract Drawings. Supply ballasts and wiring to control all top or inboard lamps together and control all bottom or outboard lamps together.
 - l. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
 - m. Provide lamps for all luminaires.
7. Ceiling Coordination
- a. Verify type of ceiling construction prior to releasing luminaires for fabrication and delivery.
 - b. Provide mounting appurtenance, flanges, sloped ceiling adaptors where required.
 - c. Provide mounting assembly, clips or other mechanical mounting lugs as required for support of luminaires.
8. Track-Lighting Systems:
- a. A lighting track system is defined as a manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length may be altered by addition or subtraction of sections of track. Lighting track may be either flexible or rigid depending on the specific application.
 - b. Provide lighting track types as specified in Luminaire Schedule, in lengths as indicated on lighting plans.
 - c. All line voltage track lighting systems shall be provided with integral current limiters or be fed from supplementary overcurrent protection panels to limit power consumed by track.
 - d. Lighting track system includes current carrying conductors which may convey either line voltages (120V or 277V) or low voltages (12V or 24V). Characteristics of lighting track that conveys line voltages are different than a lighting track system that conveys low voltages and as such are governed by different requirements. Therefore, they are considered individually in these Specifications.
 - 1) Line voltage (120V or 277V) Lighting Track systems:
 - a) Provide components, including track, fittings, and luminaires from the same manufacturer as recommended by manufacturer for the intended use. All components shall be UL Listed and comply with the National Electric Code Standards for Lighting Track.
 - b) Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of live and neutral conductors must always be maintained along continuous run so that track fittings connect into the track in a consistent manner.

- c) Support lighting track at intervals recommended by the track manufacturer.
 - d) One or two circuit Lighting Track shall be supplied with separate neutral busbars and have the ability to have each circuit separately dimmed as required when using standard voltage and low voltage luminaires with either magnetic or electronic transformers.
 - e) Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run.
 - f) One and two circuit 120 volt Lighting Track shall be rated at 120/250 volt, 60 Hz, 2,400 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
 - g) One and two circuit 277 volt Lighting Track shall be rated at 277 volt, 50/60 Hz, 5,540 watts maximum each circuit. Neutral busbar(s) shall be oversized and comparable to #10 AWG 30 amp wire to reduce the possibility of overheating due to non-linear loads and harmonics.
 - h) A separate grounding busbar shall be integral in all track lengths.
 - i) 277 volt Track fittings shall be identified by a red rotor and a 277 volt label.
- 2) Low voltage (12V or 24V) Lighting Track systems:
- a) Provide components, including track conductors, remote mounted transformers, fittings, and luminaires from the same manufacturer as recommended by the manufacturer for the intended use. Components shall be UL Listed as applicable for low voltage use.
 - b) Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of conductors must always be maintained along continuous run so that track fittings connect into track in a consistent manner.
 - c) Support lighting track at intervals recommended by track manufacturer.
 - d) One and two circuit low voltage Lighting Track shall be supplied with three conductors and have the ability to have each circuit separately switched with either magnetic or electronic transformers provided by the track manufacturer. Two circuit low voltage Lighting Track can only be dimmed if

- both circuits are fed from the same transformer and as a result, separate circuit dimming shall not be attempted or permitted.
- e) All transformers shall be supplied with both primary and secondary voltage over-current protection devices that shall remain readily accessible for maintenance and testing purposes.
 - f) Lighting Track shall have the ability to be dimmed or switched in selected sections in addition to dimming or switching an entire track configuration or track run. Separate, single circuit transformers are required for each independently controlled circuit with the use of electrically isolated couplers.
 - g) Conductors used in low voltage Lighting Track shall be, at minimum, equivalent to #10 AWG 30 amp wire or heavier and be capable of carrying a 300 watt load (at 12 volts) up to 32 ft from transformer feed within range of luminaire voltage tolerance. At 24 volts, conductors shall be capable of supplying a 600 watt load up to 60 ft from transformer feed within range of luminaire voltage tolerance.
 - h) If taut strung cable conductors are used as low voltage Lighting Track system, they shall have a Kevlar core to prevent strain on outer current carrying conductors.
 - i) Only insulated type taut strung cable conductors shall be used in order to comply with local electrical codes governing installation.
9. Outdoor Lighting Systems:
- a. Provide luminaires, mounting arms, brackets, poles, hand-hole covers, base components, and all other accessories for a complete assembly. Manufacturers shall be responsible for proper fitting of elements and structural integrity of unit.
 - b. Provide poles as shown on luminaire schedule.
 - 1) Poles shall have hand-holes.
 - 2) Fusing for each luminaire head shall be located in hand-hole near base of pole.
 - 3) Pole base anchor bolts shall be galvanized.
 - c. Exterior Luminaires:
 - 1) Shall operate at a minimum ambient temperature of 0°F.
 - 2) Shall be fully gasketed, with UL wet location label.
 - 3) Shall have approved wire mesh screens for ventilation openings.
 - 4) Anodized aluminum reflectors shall have minimum of 0.00079" anodizing thickness.
 - d. Pole/Luminaire combination shall have EPA rating that will withstand site wind conditions.

- e. All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
- f. Aluminum surfaces shall receive a duronodic or polyester powder paint finish.
- g. Cast-in Luminaire housings installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
- h. Where cast aluminum housings are used, give two coats of asphaltum paint prior to installation.
- i. Provide 1/8" thick x 2" diameter solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.3 DRIVERS

- A. LED Drivers and Power Supplies shall:
 - 1. Operate system LEDs within the current limit specification of the LED manufacturer.
 - 2. Be supplied with over-temperature protection circuitry.
 - 3. Be programmable where noted in the Luminaire Schedule to allow for LED replacement modules to be "tuned" to match the output of remaining adjacent modules in the event that some time has passed and there has been lumen depreciation.
 - 4. Be within a NEMA enclosure.
 - 5. Be equipped with knockouts to accommodate standard conduit sizes.
 - 6. Have a Power Factor to be = or > than 0.9
 - 7. Have a Lamp Current Crest Factor < 1.5
 - 8. Dimmable LED drivers must be compatible with dimming system(s) provided and control luminaires per luminaire schedule and controls documentation.
 - 9. ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.
 - 10. Class A sound rated
 - 11. Equipped with resetting thermal sensitive device.
 - 12. For operation at 60 Hz and voltage as scheduled.
 - 13. Meet or exceed all ANSI or NEMA standards.
 - 14. Capable of operating LEDs with less than 5% flicker.
 - 15. Be DMX compatible in Color changing LED luminaires.

2.4 LOW VOLTAGE TRANSFORMERS

- A. Transformers shall be:
 - 1. Sized to compensate for voltage drop over indicated distances.
 - 2. Locally fused.
- B. Transformers shall have line voltage switch within reach.

- C. Provide adequate ventilation to meet code and manufacturers requirements.

2.5 TANDEM WIRED LUMINAIRE PAIRS

- A. Luminaires may be tandem wired in a master/satellite configuration to minimize the use of single lamp ballasts or to minimize circuit connection points.
- B. Tandem wiring shall consist of UL Listed wiring system fabricated by luminaire manufacturer to interconnect ballast wiring from "master" luminaire to unballasted "slave" luminaire.
- C. Wiring shall be:
 - 1. #12 AWG minimum.
 - 2. Enclosed in 3/8" diameter flexible metallic conduit.
- D. Tandem wiring shall not be used for luminaires spaced greater than 10 ft apart (on center).
- E. Support conduit with nylon tie wraps or metal clips.

2.6 LAMPS

- A. Provide lamps as noted on Luminaire Schedule.
- B. Provide lamps of same type from same manufacturer.
- C. Where a specific lamp manufacturer has been indicated in the Luminaire Schedule, lamps shall be supplied from named manufacturer only.
- D. White LED sources shall be:
 - 1. Minimum CRI of 85 unless noted otherwise on Luminaire Schedule.
 - 2. Less than 3% flicker.
 - 3. Within 0.004 on the CIE 1976 diagram for color spatial uniformity.
 - 4. Within 0.007 on the CIE 1976 diagram for color maintenance over the rated lifetime of the source.
 - 5. Binned within a 3-step MacAdam ellipse minimum, or as indicated in Luminaire Schedule.
 - 6. Color temperature as noted on Luminaire Schedule.
 - 7. Have a published life rating based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources and IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources.
 - 8. L70 rated life shall be a minimum of 50,000 hours.

9. LED modules, unless noted otherwise, shall be provided by light fixtures manufacturer and integral to luminaire.
- E. , except quartz lamps and lamps which are dimmed shall be rated for 120 volt operation.
- F. Low voltage incandescent lamps, MR16 type, shall have a minimum of 10,000 hour rated life.
- G. Provide all other lamp types and special purpose lamps as noted on Luminaire Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Marking:
 1. Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.
 2. Lamp/ballast coordination: Luminaires equipped with ballast for operation of rapid start lamps shall be plainly marked "Use Rapid Start Lamps Only". Similarly, luminaires equipped with ballasts or other components requiring use of specific types of lamps shall be plainly marked.
 3. Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when lamps are in place.
- B. Installation of Luminaires:
 1. Lamps, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
 2. Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.
 3. Light leaks between ceiling trim of recessed luminaires and ceiling are not allowed.
 4. Locations
 - a. Install luminaires at locations and heights as indicated.
 - b. Do not scale electrical drawings for locations of luminaires.
 - c. Architectural reflected ceiling plans show locations of luminaires.

- d. Where noted on the drawings, the exact location of luminaires shall be confirmed (in the field) with the Owner's Representative prior to installation.
 - e. Where luminaires are to be concealed, or surface mounted in highly visible public spaces, a small sampling of luminaires shall be installed, adjusted and aimed for Owner's Representative review approval, prior to installing remaining luminaire of same type.
 - f. Mount all luminaires so as to maintain full range of motion.
 - g. Install luminaires plumb, square, and level with ceilings and walls.
 - h. Coordinate stem, rod, chain, or aircraft cable hanger lengths with job conditions.
 - i. Industrial type luminaires in unfinished areas, which are near obstructions such as ducts and pipes, shall be:
 - 1) Suspended so that bottom of luminaire is no higher than bottom of obstruction.
 - 2) Located at height of lowest luminaire.
 - 3) Minimum height: 8'-0"
 - 4) Shall not be located until locations of obstructions are determined.
 - 5) Where a minimum height of 8'-0" is unachievable, wall mounted luminaires will be utilized.
5. Support
- a. Support surface mount luminaires from building structure.
 - b. Metal decking shall not be pierced for luminaire support.
 - c. Provide luminaires and/or luminaire outlet boxes with hangers to support luminaire weight.
 - d. LED troffers shall be held in place by support clips.
 - e. Provide plaster frames for recessed luminaires in plaster ceilings.
 - f. Rigid metallic pipe stems shall be utilized for the support of pendant mounted luminaires, unless otherwise noted.
 - g. Stem hangers shall be equipped with aligner box covers or canopies so that stems hang vertically, irrespective of the angle of the surface they are mounted from.
 - h. Wherever a luminaire or its hanger canopy is attached to a surface mounted outlet box, a finishing ring shall conceal the outlet box.
 - i. Yokes, brackets and supplementary supporting members needed to mount luminaires to suitable ceiling members shall be furnished and installed by Contractor. Verify mounting hardware required prior to installation.
 - j. Recessed luminaires shall be supported with 12 ga wire hangers, 2 per luminaire, at diagonally opposite corners.
 - k. LED troffers and luminaires over 55 lbs, such as 4' x 4' shall be supported with 12 ga wire hangers, 4 per luminaire, 2 at 45-degree diagonals, and two

- perpendicular to structure. Wire hangers and attachment to structure shall be capable of supporting 4 times luminaire weight.
- l. In areas with seismic requirements, suspended or pendant mounted luminaires shall be able to swing 45 degrees in any direction without hitting an obstruction. In the event hitting an obstruction is unavoidable, guy wires will be used to secure the luminaire in place.
 - m. Surface luminaires installed in grid ceilings shall be supported by independent support clips and 12 ga wire.
 - n. Exit signs installed in grid ceilings shall be supported by electrical box hanger and additional 12 ga wire installed from box to structure.
 - o. Support surface mounted luminaires greater than 2 ft in length at a minimum of each additional 2 ft, or as recommended by manufacturer.
 - p. Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.
 - q. Rigidly align continuous rows of luminaires.
 - r. Luminaire types with remote mounted ballast shall have:
 - 1) Proper support for ballast weight.
 - 2) Mounting distance from remote ballast to luminaire per manufacturer's recommendations.
6. Mounting and Enclosures
- a. Install flush mounted luminaires to eliminate light leakage.
 - b. For luminaires mounted adjacent to insulation, provide barrier to prevent insulation from coming in contact with luminaire, unless luminaire is approved for installation in contact with such insulation.
 - c. Provide approved fire rated enclosures around luminaires in fire rated ceilings.
7. Conduit and Wiring
- a. Wire for connections to lamp sockets and auxiliaries shall be suitable for temperature, current, and voltage conditions.
 - b. Recessed luminaires shall have final connections made with flexible metal conduit, not in excess of 72", with THHN conductors and green wire ground conductor.
 - c. Conduit shall be hidden from normal view in all possible cases. In public areas where surface mounted conduit must be used, contractor shall install conduit as unobtrusively as possible. Contractor shall obtain field approval by the Owner's Representative for all exposed conduit runs prior to rough in.
8. In-Grade Luminaires:
- a. Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.
 - b. Provide adequate drainage system per manufacturer's recommendations.

- C. Installation of Outdoor Pole Bases
 - 1. Contractor shall provide bases for luminaires.
 - 2. Pole base details shall be provided by the project structural engineer.
 - 3. Provide handhole for electrical connection within 4'-0" of pole base.
 - 4. Contractor shall:
 - a. Rough-in conduits.
 - b. Coordinate spacing, base dimensions, heights, orientation of bases, etc. as necessary.
 - 5. Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Owner's Representative.

- D. Pole Installation:
 - 1. Install luminaires, poles, hardware, etc., for complete system.
 - 2. Use web fabric slings (not chain or cable) to raise and set poles.

- E. Lamps:
 - 1. Provide new lamps delivered in original manufacturer's cartons.
 - 2. Fluorescent, LED and metal halide lamps shall be energized continuously for not less than 100 hours for proper seasoning.

- F. Grounding:
 - 1. Ground luminaires and metal poles according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 2. Poles:
 - a. Install 10 ft driven ground rod at each pole.
 - 3. Non-metallic Poles:
 - a. Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with #10 AWG conductor.

- G. Spare Parts:
 - 1. Provide spare globes and guards, 1 for every 100 of each type and rating installed. Furnish at least one of each luminaire family.
 - 2. Provide spare louvers and reflector cones, 1 for every 100 of each luminaire family. Furnish at least one of each type.
 - 3. Provide spare plastic diffusers and lenses, 1 for every 100 of each luminaire family and rating installed. Furnish at least one of each type.
 - 4. Furnish one spare custom luminaire for each 10 supplied.
 - 5. Provide 1% spare replaceable LED lamp modules for each primary fixture series type in Luminaire Schedule. In all cases, provide a minimum of 1 unit.
 - a. Spare LED lamp modules shall be delivered to Owner's Representative in new condition and in original packaging.
 - b. Manufacturer and model number shall match those installed in the project's luminaires.

6. Provide spare LED drivers, 1 for every 100 of each primary fixture series type and rating installed. Furnish at least one of each type.
 - a. Manufacturer and model number shall match those installed in the project's luminaires.
7. Provide 1% spare LED luminaires with non-replaceable lamp modules consisting of entire LED luminaire assembly and driver(s).

3.2 SUBSTANTIAL COMPLETION

A. Quality Control:

1. At Date of Substantial Completion, replace lamps/LED modules/LED luminaires which are not operating properly.
2. Replace any lamps used as worklights during construction phase.
3. Protection wrapping on lensed or louvered luminaires shall be removed before installation of furniture, but after finish work is complete.
4. Deliver spare equipment to Owner's representative.

B. Tests:

1. Give advance notice of dates and times for field tests.
2. Provide instruments to make and record test results.
3. Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized.
4. Verify operation of luminaires with lighting control system and daylight harvesting systems. Any dimmed fixtures shall exhibit no signs of flickering.
5. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.
6. Report results of tests.

C. Adjusting and Cleaning:

1. Clean luminaires of handling marks, dust and dirt.
2. Cleaning and touch-up work shall be performed in accordance with luminaire manufacturer's recommendations.
3. Damaged luminaires or components shall be replaced with new.
4. Keep luminaires clean and protected for remainder of construction period.
5. Verify orientation of directional luminaires prior to installation.
 - a. This includes wall washers, cove lighting, floodlights, exterior area lights and adjustable accent luminaires. Contractor shall provide electrician's services to aim, adjust, and focus luminaires, as required, at direction of Owner's Representative and shall be provided at no extra charge to Owner over base bid. Contractor shall provide equipment for luminaries' focus including ladders and mechanical lifting systems.
6. Program preset dimming system lighting levels.

7. Program ambient light sensors integral to luminaires for appropriate illumination levels as indicated in control narrative or in lighting control specifications.
8. Program occupancy sensors integral luminaires for appropriate time delay as indicated in control narrative or in lighting control specifications.
9. Exterior poles, bollards, bases and other exterior luminaires shall be painted to match factory color where finish has been damaged.
10. No light leaks shall be permitted at ceiling line from any visible part or joint.

D. Training

1. Contractor shall provide Owner's Representative with 3 complete copies of Operations and Maintenance manuals.
 - a. All "Approved as Noted" comments shall be corrected/picked-up in this record manual set.
 - b. Each manual shall contain specific information pertaining to the equipment installed. Each manual shall contain at a minimum:
 - 1) Detailed as built shop drawings for all lighting equipment installed.
 - 2) Manufacturer's product cut sheets for all equipment installed keyed by type as to as built drawings.
 - a) Luminaires
 - b) Control gear/ballasts/drivers
 - c) Lamps
 - 3) Manufacturer's complete installation instructions for all equipment installed keyed by type to as built drawings.
 - a) Luminaires
 - b) Control gear/ballasts/drivers
 - c) Lamps
 - 4) Equipment maintenance requirements and schedules.
 - a) Luminaires
 - b) Control gear/ballasts/drivers
 - c) Lamps/LEDs
 - 5) Equipment manufacturer contacts.
 - a) Luminaires
 - b) Control gear/ballasts/drivers
 - c) Lamps/LED modules
 - 6) Equipment manufacturer warranties.
 - a) Luminaires
 - b) Control gear/ballasts/drivers
 - c) Lamps/LED modules
2. Contractor shall provide qualified personnel onsite to provide a minimum of three days of training to Owner's representatives.
3. This training shall cover:
 - a. Luminaire use and maintenance

- b. Architectural lighting system use and maintenance
- c. Group relamping cycles

END OF SECTION 26 50 00

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SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of exterior luminaires, controls, poles and supports.

1.2 RELATED WORK

- A. Section 26 05 00, COMMON WORK RESULTS FOR ELECTRICAL.
- B. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings, and boxes for raceway systems.
- C. Section 26 05 19, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage power and lighting wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- E. Section 26 51 00, INTERIOR LIGHTING.
- F. Section 26 56 70, LIGHTING ACCEPTANCE TESTING.

1.3 SUBMITTALS

- A. Submit in accordance with Division 1 requirements.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, poles, luminaires, effective projected area (EPA), lamps and controls.

1.4 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- B. American Society for Testing and Materials (ASTM).
- C. American Concrete Institute (ACI).
- D. American National Standards Institute (ANSI).
- E. Aluminum Association Inc. (AA).
- F. Illuminating Engineering Society of North America (IESNA).
- G. National Electrical Manufacturers Association (NEMA).
- H. National Fire Protection Association (NFPA).
- I. Underwriters Laboratories, Inc. (UL).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Poles: Do not store poles on ground. Store poles so they are at least one foot above ground level. Do not remove factory-applied pole wrappings until just prior to installation of pole.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be in accordance with CEC, UL, ANSI, as shown on the drawings and as specified.

2.2 POLES

- A. General:
 - 1. Poles shall be steel as specified in fixture schedule and as shown on the drawings. Finish shall be as approved by the Architect.
 - 2. The pole and arm assembly shall be designed for wind loading of 100 miles per hour, with an additional 30 percent gust factor, supporting luminaire(s) having the effective projected areas indicated as per manufacturer data.
 - 3. Poles shall anchor-bolt type designed for use with underground supply conductors. Poles shall have gasketed handhole with a minimum clear opening of 2.5" x 5". Handhole cover shall be secured by stainless steel captive screws.
 - 4. Provide a steel grounding stud opposite hand hole openings.
- B. Provide a base cover matching the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts.

- C. Hardware: All necessary hardware shall be 300 series tamperproof stainless steel.
- D. Types:
 - 1. Steel: Provide steel poles having minimum 11-gage steel with minimum yield/strength of 48,000 psi and iron-oxide primed factory finish. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 36,000 psi.

2.3 FOUNDATIONS FOR POLES

- A. Foundations shall be cast-in-place concrete.
- B. Foundations shall support the effective projected area of the specified pole, arm(s), luminaire(s), and all accessories specified under wind conditions as specified in this section.
- C. Place concrete in spirally wrapped treated paper forms for round foundations, and construct forms for square foundations.
- D. Rub-finish and round all above-grade concrete edges to approximately 1/4" radius unless otherwise detailed.
- E. Concrete shall have 3000 psi minimum 28-day compressive strength.
- F. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings and meet ACI 318. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.
- G. Install a copperclad ground rod, not less than 5/8" diameter by 8' long in pullbox adjacent to each fixture. Where rock or layered rock is present, drill a hole not less than 2" in diameter and 6' deep, backfill with tamped fine sand and drive the rod into the hole. Bond the rod to the pole with not less than number 6 AWG bare copper wires. The method of bonding shall be approved for the purpose.
- H. After leveling of pole grout base solid between plate and footing with dry pack concrete for vibration reduction.

2.4 LUMINAIRES

- A. UL 1598 and ANSI C136.17. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat and safe cleaning and relamping.

- B. Light emitting diode (LED)-based solid state lighting (SSL) products shall be factory tested in accordance to the International Engineering Society (IES) LM-79 recommendations and meet ANSI C78.377-2008 standards.
- C. LED light sources shall be factory tested in accordance to IES LM-80 recommendations.
- D. LED-based SSL product shall incorporate an external heat sink, integral to the luminaire.
- E. IESNA HB-9 and RP-8 light distribution pattern types shall be as indicated on the drawings.
- F. Incorporate associated ballasts and drivers within the luminaire housing.
- G. Lenses shall be frame-mounted heat-resistant, borosilicate glass, prismatic refractors. Attach the frame to the luminaire housing by hinges or chain.
- H. Pre-wire internal components to terminal strips at the factory.
- I. Bracket mounted luminaires shall have leveling provisions and clamp type adjustable slip-fitters with locking screws.
- J. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
- K. LED-based SSL luminaires shall be manufactured specifically for LED lamps with drivers integral to the luminaire housing.

2.5 LED-BASED SOLID-STATE DRIVERS

- A. Shall be listed by either U.L. or equal listing agency and comply with IEEE C.62.41-1991, Class A operation.
- B. Provide a minimum power factor of 0.9.
- C. Minimum operating temperature appropriate for outdoor environments.
- D. Shall operate at a frequency greater than or equal to 120Hz.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lighting in accordance with the CEC, as shown on the drawings, and in accordance with manufacturer's recommendations.

- B. Poles:
1. Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad 90 degrees at the bottom end. Provide galvanized nuts, washers, and ornamental covers for anchor bolts. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit elbow. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.
 2. After the poles have been installed, shimmed and plumbed, grout the spaces between the pole bases and the concrete base with non-shrink concrete grout material. Provide a plastic or copper tube, of not less than 3/8" inside diameter, through the grout tight to the top of the concrete base for moisture weeping.
 3. Attach pole base cover to pole flange with set screws.
- C. Foundation Excavation: Depth shall be as required. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6" maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.
- D. Spare parts: Provide 1% or minimum of 1 fixture head for each type of fixture installed.

3.2 GROUNDING

- A. Ground noncurrent-carrying parts of equipment including metal poles, luminaries, mounting arms, brackets, and metallic enclosures as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or alloyed connectors suitable and listed for this purpose.

END OF SECTION 26 56 00

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SECTION 27 00 00 - COMMUNICATIONS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This document contains the General and Supplementary Conditions that are a part of the requirements for the work under this Division of the Specifications.
- B. The term “Telecommunications” systems/components is understood to include TELEPHONE, DATA, CATV systems/components and Radio (RF) systems and components when such systems and/or components are part of the Cal Poly Campus Project.

1.02 QUALITY ASSURANCE

- A. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations, and requirements of the utility companies serving the project and the campus’ insurance underwriter.
- B. Drawings, specifications, codes, and standards are minimum requirements. Where requirements differ, the most stringent apply.
- C. All equipment and installations shall meet or exceed the minimum requirements of ADA, ANSI, ASTM, IEEE, TIP, NEC, NEMA, NFPA, OSHA, UL, ITS Telecommunications Standards Document (TSD), the Manufacturer and the State Fire Marshall.
- D. Should any change in drawings or specifications be required to comply with governing regulations, notify and receive written approval from the Cal Poly ITS Telecom group representative prior to submitting your bid.
- E. ***Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced, full-time Superintendent and Project Manager who are authorized to make decisions on behalf of the Contractor.***
- F. All telecommunications technicians must have a manufacturer’s certification for the Structured Cable System (SCS) components that they are installing.
- G. Provide all components of a complete system specified within all project documents, specifications and drawings.
- H. All unused component parts from all system installations shall be delivered to the Cal Poly ITS Telecomm group and shall not disposed of or thrown away.
- I. Contractors shall use the strictest manufacturer written recommendations, specifications, and the Cal Poly ITS Campus Telecommunications Standards Document.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. The references to the following codes and standards are meant to represent the most current and up-to-date revisions or printing as of the issue of this document. The Contractor is responsible for following the correct revision or printing (UON).
- B. ANSI/TIA/EIA-526 (Optical Power Loss Measurements of Installed Fiber Cable Plant to include OTDR)
- C. ANSI/TIA/EIA-568-C (Commercial Building Telecommunications Standard)
- D. ANSI/TIA/EIA-569-B (Commercial Building Standards for Telecommunications Pathways and Spaces)
- E. ANSI/TIA/EIA-598-C (Optical Fiber Cable Color Coding)
- F. ANSI/TIA/EIA-604 (Fiber Optic Connector Intermate ability Standard)
- G. ANSI/TIA/EIA-606-A (Administration Standard for the Telecommunications Infrastructure of Commercial Buildings)
- H. ANSI/TIA/EIA-607-A (Grounding & Bonding Requirements for Telecommunications in Commercial Buildings)
- I. ANSI/TIA/EIA-758-A (Customer-owned Outside Plant Telecommunications Cabling Standard)
- J. ANSI/TIA/EIA-854 (Full Duplex Ethernet Specification for 1000Mbit/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling)
- K. ANSI/TIA/EIA-862 (Building Automation Cabling Standard for Commercial Buildings)
- L. International Standards Organization/International Electro-technical Commission (ISO/IEC)
- M. Underwriters Laboratories (UL) Cable Certification and Follow Up Program
- N. National Electrical Manufacturers Association (NEMA)
- O. American Society for Testing Materials (ASTM)
- P. Institute of Electrical and Electronic Engineers (IEEE)
- Q. UL Testing Bulletin
- R. American National Standards Institute (ANSI)
- S. Telecommunications Distribution Methods Manual 14th Edition (BICSI)
- T. CSU Telecommunications Infrastructure Planning Standards (Third Edition)– March 2022
- U. Cal Poly ITS Telecommunication Standards Document – February - 2023
- V. NFPA 101 (NFPA 101 - Life Safety Code).
- W. NFPA 258 - Standard Test Method for Measuring Smoke Generated by Solid Materials.
- X. NFPA 70 - National Electrical Code – 2017
- Y. NFPA 72 National Fire Alarm & Signaling Code – California Amended 2016 Edition
- Z. CEC 2019 California Electrical Code (Title 24, Part3) – 2017 NEC with California Amendments
- AA. The California Mechanical Code
- BB. IEEE's National Electrical Safety Code – 2017

- CC. ANSI C80.3 Specification for Zinc-coated Electrical Metallic Tubing
- DD. ANSI/UL 797 Electrical Metallic Tubing
- EE. ANSI/ICEA S-83-596 - Fiber Optic Premises Distribution Cable Technical Requirements
- FF. Federal Communications Commission (FCC) Part 15
- GG. Federal Communications Commission (FCC) Part 68
- HH. NEMA VE1 Cable Tray Systems
- II. UL 497 Electrical Grounding and Bonding Equipment
- JJ. UL 1479 Fire Tests of Through-Penetration Fire Stops
- KK. ASTM E 814 Methods of Fire Tests of Through-Penetration Fire Stops
- LL. ASTM E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C
- MM. Rural Utility Services (RUS), Bulletin 1753F-201, Specifications for Acceptance Tests and Measurements of Telecommunications Plant
- OO. BICSI TDMM (Telecommunications Distribution Methods Manual) 14th Edition

1.04 SUBMITTALS

A. General

1. Review of submittals shall be for general compliance with the design concept and Contract Documents.

Comments or absence of comments shall not relieve the Contractor from compliance with the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.

2. Submittals will be stamped as follows:

Stamp	Interpretation
No Exceptions Noted	Fabrication, manufacture, or construction may proceed providing submittal complies with the
Exceptions Noted <input type="checkbox"/> Resubmit for Record <input type="checkbox"/> No Resubmission Required	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents and the Engineer’s notations are complied with.
Revise and Resubmit	The submittal does not comply with the Contract Documents; do not proceed with fabrication, manufacture, or construction. The work and shop drawings are not permitted at the job site. Resubmit appropriate shop drawings.

3. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted by the Cal Poly ITS Telecomm group.
 4. A minimum period of five working days, exclusive of transmittal time, shall be required in the Cal Poly ITS Telecomm representative's office each time a shop drawing, product data and/or samples shall be submitted for review. This time period shall be considered by the Contractor in the scheduling of the work.
 5. Submit materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalog material.
 6. Maintenance and operating manuals shall not be acceptable substitutes for shop drawings.
 7. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finish.
 8. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- B. Samples
1. Samples as requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Samples shall not be returned to the Contractor.
- C. Test Reports
1. Pre-Installation Testing Reports: Submit two sets of manufacturers or field-testing reports for those materials identified in the individual system Specification Sections as requiring that such reports shall be submitted.
 2. Post-Installation Testing Reports: Submit a minimum of two sets of field-testing reports for those materials identified in the individual system Specification Sections as requiring that such reports shall be submitted.
- D. Vender/Contractor/Supplier Information
1. Submit a complete typed list of all telecommunications infrastructure equipment manufacturers and material suppliers for the equipment proposed to be provided on this project, as well as names of all subcontractors.
 2. Contractor must supply current manufacturer's certification for all employees involved in the installation of all materials contained as part of the Structured Cabling System.
- E. Warranty info
1. Submit a copy of all relevant warranty information.
- F. Product Documentation:
1. Documentation for submittals in the form of catalog cuts, manufacturer specifications, and other supporting printed material shall be bound in a single binder, tabbed and separated by specification section, and submitted in its entirety for review and eventual delivery to the Cal Poly ITS Telecomm group.
- G. Shop Drawings
1. After the Contract is awarded, provide complete shop drawings as requested for each relevant section. Prior to submission, certify that the shop drawings shall be in compliance with the

Contract Documents. Modify any work which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.

2. Shop drawings for Telecommunications Room (TR) layout, specifically including details for wall-fields and rack mounting layouts shall be approved by a representative of the Cal Poly ITS Telecomm group prior to installation.
3. For each room or area of the building containing telecommunications infrastructure equipment, submit the following:
 - a. Floor plans, at not less than 1/8" scale, showing routing of telecommunications conduits, cable trays and other pathways.
 - b. Riser diagrams showing types, quantities and schematic routing of all telecommunications backbone pathways, cabling and the TBB.
 - (1) Enlarged plan views and elevation layout drawings for the telecommunications Entrance Facility (EF) room, Telecommunications Rooms (TRs) and all other designated telecommunications Equipment Rooms (ERs) indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than ¼ inch = 1'-0". They shall be prepared in the following manner:
 - (2) Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
 - (3) Illustrate all telecommunications hardware proposed to be contained therein. Include top and bottom elevations of all telecommunications hardware. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
 - (4) Illustrate all other equipment therein such as conduits, detectors, luminaires, ducts, registers, pull boxes, wire-ways, structural elements, etc.
 - (5) Illustrate concrete pads, curbs, etc.
 - (6) Indicate dimensions to confirm compliance with code-required clearances.
4. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job.
5. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
6. The Contractor shall not be relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and shall be neither waived nor superseded in any way by the review of shop drawings, product data and samples.
7. Inadequate or incomplete shop drawings, product data and/or samples shall not be reviewed and shall be returned to the Contractor for resubmittal.
8. Indicate the following on the lower right-hand corner of each shop drawing and on the front cover of each product data brochure cover: The submittal identification number; title of the

sheet or brochure; name and location of the project; names of the Architect, Engineer, Contractor, Subcontractor, manufacturer, supplier, and vendor; the date of submittal; and the

date of each correction, version and revision. Number all pages and drawings in product data brochures consecutively from beginning to end. Unless the above information is included, the submittal shall be returned for re-submission. Resubmittals of product data or brochures shall include a cover letter summarizing the corrections made in response to the review comments.

9. The telecommunications room layout submittals and the related telecommunications equipment submittals shall be submitted concurrently. Failure to submit concurrently shall result in the immediate return of the submittal marked REVISE AND RESUBMIT.

1.05 IDENTIFICATION

- A. Also refer to Section 27 05 53.
- B. Label and identify each element as required for those individual system specification sections.
- C. Use Cal Poly ITS Telecomm Labeling, Design and Syntax Standard on all Shop Drawings and Submittals.

1.06 ABBREVIATIONS AND DEFINITIONS

A. ABBREVIATIONS

1. ADA Americans with Disabilities Act
2. AFF Above Finished Floor
3. ANSI American National Standards Institute
4. ASTM American Society for Testing and Materials
5. BICSI (Building Industry Consulting Service International)
6. EIA Electronic Industries Alliance
7. ETL Electrical Testing Laboratories, Inc.
8. FCC Federal Communications Commission
9. FM Factory Mutual
10. ISO/IEC 11801-1 2017
11. IEEE Institute of Electrical and Electronic Engineers
12. LED Light Emitting Diode
13. NEC National Electric Code
14. NEMA National Electrical Manufacturers Association
15. NFPA National Fire Protection Association
16. NRTL Nationally Recognized Testing Laboratory
17. OEM Original Equipment Manufacturer
18. OSHA Occupational Safety and Health Administration
19. SCC Security Control Center

20.	SCS	Structured Cabling System
21.	TBB	Telecommunications Bonding Backbone
22.	TGB	Telecommunications Grounding Bus-Bar
23.	TIA	Telecommunications Industries Association
24.	TMGB	Telecommunications Main Grounding Bus-Bar
25.	TIP	Telecommunications Infrastructure Planning
26.	UL	Underwriters Laboratories
27.	UON	Unless Otherwise Noted

B. Telecommunications Definitions

1. **BACKBOARD:** Backboard generally refers to the A-C, fire-retardant, plywood sheeting lining the walls of the telecommunications facilities. Backboards may also refer to the entire wall-mounted assembly, including wire management and termination frames.
2. **BUILDING ENTRANCE FACILITY (EF):** See ROOM TAXONOMY
3. **CATV:** Cable Antenna Television System.
4. **CABLE PLANT:** Cable, conduit raceways, vaults, junction/pull boxes, rooms, racks, equipment, patch bays/blocks, and other infrastructure required to provide physical, electrical, optical connectivity between buildings on the Campus.
5. **CABLE TRAY:** Hardware designed and manufactured for horizontal pathway distribution of cable and inside wire from the Telecommunications Room (TR) to the Information Outlet.
6. **CAL POLY ITS TELECOMM GROUP REPRESENTATIVE:** Telecommunications representative for the project shall be designated and changed as necessary by the Supervisor of Cal Poly ITS Telecomm group.
7. **DESIGNATION STRIPS:** Paper or plastic strips, usually contained in a clear or color tinted plastic carrier, designated for insertion into a termination frame. Designation strips are usually imprinted with the adjacent terminal number and are used to aid in locating a specific pair, group of pairs, or information outlet inserted into the termination frame, or for the purpose of delineating a termination field.
8. **ENTRANCE CONDUIT:** Conduit that connects the underground infrastructure with the building's EF.
9. **HORIZONTAL CABLE:** See STATION CABLE
10. **MPOE/DEMARK:** Minimum Point of Entry, Utility Partnerships/Alternate Carrier and inaccessible or non-standard customer wiring located in or connected to an EF/ TR/ER, MPER and/or MCER.
11. **WIRE MANAGEMENT HARDWARE:**
 - a. **Fiber Management:** Hardware designed and manufactured for the purpose of keeping fiber patch cords neat and orderly. Most termination frame manufacturers provide fiber management components designed to work in conjunction with their termination frames. Fiber management may also refer to other types of hardware for the purpose of securing fiber optic cable to the building.
 - b. **Wire Management (Copper, Data, Network):** Hardware designed and manufactured for the purpose of keeping cross-connect wire and patch cables neat and orderly. Most termination frame manufacturers provide wire management components designed to work in conjunction with their termination frames. Wire management may also refer to other types of hardware for the purpose of securing wire and cable to the building.
12. **OUTSIDE PLANT (OSP):** Communications system components outside of the buildings (typically underground conduit and vaults, exterior/underground rated wire, cable, fittings, etc.).
13. **RISER CABLE:** High volume cable (copper) that connects between ERs/TRs, patch panels or backboards located on the same or different floors. All riser cable is to be plenum rated.
14. **RISER CONDUIT:** Conduit that connects between ERs/TRs or backboards located on the same or different floors.

15. RISER FIBER CABLE: Fiber Optic Cables that connects between ERs/TRs or racks located on the same or different floors. All Fiber Optic Cable to be plenum rated.
16. ROOM TAXONOMY
 - a. ENTRANCE FACILITY (EF): The EF is where the outside plant (OSP) cables connect (through protection devices and distribution cross-connects) to the telecommunications, data and CATV “backbone”. The EF should be located as close as possible to where the communications conduits enter the facility from the underground. The EF must be large enough for plywood backboards with a minimum of 36 inches of clearance in front of the entrance cross-connects and include the same door and lighting requirements as a TR. In certain project/building designs, a TR or ER could also function as an EF if sufficient additional space is provided.
 - b. TELECOMMUNICATIONS ROOM (TR): Telecommunication rooms are recognized in ANSI/TIA/EIA-569 as the transition point between the horizontal (station) pathway facilities and the backbone (riser) pathway facilities. A TR can also function as an EF provided sufficient space is added to the room. The TR generally houses telecommunications equipment, cabling, TR environmental control equipment, TR power distribution/conditioners, and uninterruptible power supply (UPS) systems. TRs must also be large enough for equipment installation/replacement without interfering with other systems (minimum 3 side-by-side equipment racks). The TR interior dimensions must be at minimum no less than 10’ x 12’ when planned to serve less than 200 communications faceplates. A TR shall be made larger if the communications outlet count is higher. EF/TRs/ERs shall be stacked above each other in multi-story buildings in a fire rated 2 hour shaft design.

TELECOMMUNICATIONS ROOM TYPES:

- (1) MAIN CAMPUS EQUIPMENT ROOM (**MCER**): Designation for a room serving as the core telecommunications and data network facility for a campus and typically acts as a gateway to the outside world.
 - (2) MAIN PROJECT EQUIPMENT ROOM (**MPER**): Designation for a room serving as the main telecommunications facility serving a project or multiple individual buildings and typically connects directly to an MCER.
 - (3) Equipment Room (**ER**): Designation for the primary telecommunications facilities for an individual building. ERs connect to a MPER or directly to a MCER via the building’s EF.
17. STATION CABLE:
 - a. 4 pair, unshielded uniform twisted pair, category rated wire that connects the end user information outlet/faceplate to the ER/TR. All station cable to be plenum rated.
 18. TELECOMMUNICATIONS GROUNDING/BONDING SYSTEM:
 - b. The Bonding Conductor for Telecommunications (BCT): The BCT shall bond the TGB to TBB, and bond the TMGB to the main facility electrical power grounding busbar.
 - c. The Telecommunications Main Grounding Busbar (TMGB): The TMGB is connected to main facility electrical grounding system and serves as the dedicated extension for the

telecommunications infrastructure. The TMGB also serves as the central attachment point for telecommunications bonding backbones (TBB) and equipment, and shall be located such that it is accessible to telecommunications personnel.

- d. The Telecommunications Grounding Busbar (TGB): The TGB is the common central point of connection for telecommunications systems and equipment for the location served by that ER/TR.
 - e. The Telecommunications Bonding Backbone (TBB): A TBB is a conductor that interconnects all TGB's with the TMGB. A TBB's basic function is to reduce or equalize potential differences between telecommunications systems bonded to it. A TBB is not intended to serve as the only conductor providing a ground fault current return path.
 - f. The Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC): Whenever two or more vertical TBBs are used within a multistory building, the TBBs shall be bonded together with a TBB interconnecting bonding conductor (TBBIBC) on the top floor (at minimum).
19. TELECOMM/DATA DEMARK: (Surface Mounted Conduit & Boxes Only and/or no Suspended Ceiling)
- A pair of separately mounted 4 11/16" square, 2 ¼" deep electrical boxes. In one box terminate a run of telecomm/data cable from the ER/TR using a single (or more if necessary) RJ45 jack, mounted in an appropriate faceplate. In the other box terminate cable(s) that shall be used to connect directly to a piece of manufactured equipment or a non-ITS supported network. To complete the cable run(s) use a "male RJ45" to "male RJ45" jumper plugged into each faceplate. (**See Fig. #166 in the Cal Poly ITS Telecomm Labeling, Design and Syntax Standard in Appendix B**).
20. TELECOMM/DATA DEMARK: (In-wall Conduit and Back Boxes with a Suspended Ceiling)
- Conduit and wiring shall be installed to a standard, ITS Telecom group in-wall 4 11/16" square, 2 ¼ " deep electrical box. The port connectors for cables to be connected directly to user equipment shall be pushed back into the back box and an extension cable shall be attached and the extension cable shall be run to the area above the hung ceiling where it will be coiled for customer use. The empty faceplate holes shall be filled with snap-in blank fillers. (See Fig. #167 in the Cal Poly ITS Telecomm Labeling, Design and Syntax Standard in Appendix B.)

1.07 WARRANTY

- A. Submit a single guarantee stating that the work is in accordance with the Contract Documents. The warranty shall include all labor to replace any defective components as well as the component replacement at current market price. Guarantee work against faulty and improper material and workmanship for a period of one year from the date of final acceptance by the University and/or the ITS Telecomm group, except where guarantees or warranties for longer terms shall be provided or specified herein, the longer term shall apply. Correct any deficiencies, which occur during the guarantee period, within 24 hours of notification, without additional cost to the University, and to the satisfaction of the Cal Poly ITS Telecomm group representative. Obtain similar guarantees from subcontractors, manufacturers, suppliers and sub-trade specialists.
- B. Structured Cabling System (SCS) Manufacturers Extended Warranty

1. The installation contractor shall have current manufacturer's certification for all materials contained as part of the SCS. All employees shall have current certifications for the materials they are installing.
2. SCS Systems shall be covered by a two-part certification program provided by a single manufacturer and that manufacturer's certified vendor. Manufacturer shall administer a follow-on program through the Vendor to provide support and service to the purchaser. The first part shall be an assurance program, which provides that the certified system will support the applications for which it is designed, during the 20-year warranty of the certified system.
3. The second portion of the certification shall be a 20-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications faceplate/connectors, cables, cross-connects, patch panels, etc.).
4. In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor shall commit to promptly implement corrective action.
5. Documentation proving the cabling system's compliance to the End-to-End Link Performance recommendations, as listed in ANSITIA/EIA-568-B shall be provided by the Vendor prior to the structured cabling system being installed.
6. The cabling system shall conform to the current issue of industry standard ANSI/TIA/EIA-568. All performance requirements of this document shall be followed. As well, workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) ITSI (Information Transport Systems Installation) manual and the Cal Poly ITS Telecommunications Standards Document – January - 2014.
7. Purchaser demands strict adherence to the performance specifications listed in ANSI/TIA/EIA-568- B series standards.
8. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacture the product used in this cabling system.

PART 2 – PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Use only products listed for their intended use by a Nationally Recognized Testing Laboratory, except products for which no relevant standards exist.
- B. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.
- C. Products and materials shall not contain asbestos, PCB, or any other material, which shall be considered hazardous by the Department of Environmental Protection or any other authority having jurisdiction.
- D. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- E. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- F. Enclosures for telecommunications/data/CATV/radio infrastructure equipment installed in

mechanical equipment rooms shall be NEMA type 1 with gasket. Enclosures for telecommunications infrastructure equipment installed outdoors shall be NEMA type 4.

- G. Ship and store all products and materials in a manner that will protect them from damage, weather, and entry of debris. If items are damaged, do not install, but take immediate steps to obtain a replacement. Repairs of damaged goods shall only be permitted with prior written permission of the Cal Poly ITS Telecomm group representative.
- H. Part numbers and product codes in these specifications shall be correct as of the time of writing. Manufacturers may, however, change part numbers and product codes on short notice. In cases where part numbers or product codes differ from technical specifications for a particular product, provide products meeting the minimum technical specifications of the products in the specifications. The contractor shall notify the Cal Poly ITS Telecomm representative of any product code and or part number changes on the material list submittal.
- I. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise on approved drawings or contract documents.

2.02 SPECIAL TOOLS

- A. Deliver to Cal Poly ITS Telecomm group representative 2 complete sets of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work.
- B. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.
- C. The terms "special tools" and "small equipment items" **are** meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars (\$500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.
- D. Submit the tool list along with the bid for this work. Include add/delete unit pricing for all tools on the list.

2.03 SUBSTITUTIONS

- A. Contract Documents shall be based on equipment manufacturers as called out in the Specifications and indicated on the Drawings. Acceptance of substitute equipment manufacturers shall not relieve Contractor of the responsibility to provide equipment and materials, which meet the performance as stated or implied in the Contract Documents.
- B. Submit proposals to provide substitute materials or equipment, in writing, with sufficient lead-time for review prior to the date equipment is ordered to maintain project schedule.
- C. Substitutions that increase the cost of the work and related trades shall not be permitted.
- D. Proposals for substitutions shall include the following information:
 - 1. A description of the difference between the Contract Document requirements and that of the substitution, the comparative features of each, and the effect of the change on the end result performance. Include the impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades.

2. Schematic drawings and details.
 3. List of revisions to the Contract Documents that must be made if the substitution is accepted.
 4. Estimate of costs the University may incur in implementing the substitution, such as test, evaluation, operating and support costs.
 5. Statement of the time by which a Contract modification accepting the substitution must be issued, noting any effect on the Contract completion time or the delivery schedule.
 6. A statement indicating the reduction to the Contract price if the Cal Poly ITS Telecomm group representative accepts the substitution. Include required modifications to all related trades.
- E. Final acceptance of Telecomm/Data/CATV/RF designs and substitutions shall be as follows:
1. Final acceptance/approval of all Telecomm/Data/CATV/RF designs and substitutions shall be at the sole discretion of the Cal Poly ITS Telecomm group.

PART 3 – EXECUTION

3.01 GENERAL

- A. Work Included
1. Provide labor and materials required to install, test and place into operation the telecommunications infrastructure systems as called for in the Contract Documents, and in accordance with applicable codes and regulations.
 2. Provide labor, materials, and accessories required to provide complete, operating telecommunications infrastructure systems.
 3. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to Cal Poly.
- B. Fees and Permits
1. Pay all required fees and obtain all required permits related to the telecommunications infrastructure installation.
 2. Pay royalties or fees in connection with the use of patented devices and systems.
 3. Provide controlled inspection where required by the authority having jurisdiction or by these specifications.
- C. Coordination of work
1. The Contract Documents establish scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.
 2. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
 3. The telecommunications infrastructure drawings show the general arrangement of equipment and appurtenances. Follow the appropriate drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the Drawings. Investigate the site, and review drawings of other trades to determine conditions affecting the work, and provide such work and accessories as

may be required to accommodate such conditions.

4. The locations of cable termination fields, faceplates, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of faceplates, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes. The final designs shall be accepted by the Cal Poly ITS Telecomm group prior to installation.
5. ***Exercise particular caution with reference to the location of outlets/faceplates, racks, blocks, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Cal Poly ITS Telecomm group representative before proceeding with the installation.***
6. The Drawings show only the general run of raceways and approximate locations of faceplates. Any significant changes in location of faceplates, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Cal Poly ITS Telecomm group representative for review before such alterations are made. Modifications shall be made at no additional cost to the University.
7. Verify with the Cal Poly ITS Telecomm group representative the exact location and mounting height of faceplates and equipment not dimensionally located on the Drawings. For power distribution to equipment located in equipment racks see the Cal Poly Labeling, Design and Syntax Standard in Appendix B.
8. Faceplate/cable labels in the form of alpha/numeric characters are used where shown to indicate the faceplate and cable designation numbers in cable termination fields (terminal blocks and/or patch panels). Show the actual faceplate/cable numbers on the as-built Record Drawings, on the associated typed termination field labels and in the printed and computer readable cabling schedules. Where faceplate/cable-numbering information is not indicated, request clarification from the Cal Poly ITS Telecomm group representative.
9. Wherever work interconnects with the work of other trades, coordinate with other trades to insure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote ballast, pull boxes, etc.) requiring access in order that the Ceiling Trade will know where to install access doors and panels.
10. Furnish and set sleeves for passage of telecommunications risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each telecommunications riser passing through building surfaces.
11. Provide appropriate firestop materials around all pipes, conduits, ducts, sleeves, etc. which pass through rated walls, partitions, and floors.
12. Provide detailed information on openings and holes required in precast members for telecommunications work.
13. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.
14. Examine and compare the Contract Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Cal Poly ITS Telecomm group representative and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before

installation, make proper provisions to avoid interferences.

15. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
16. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - a. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch.
 - b. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - c. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
17. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Cal Poly ITS Telecomm group.
18. Coordinate with Cal Poly ITS Telecommunications group representative for access into existing campus telecommunication spaces.

D. Cutting and Patching

1. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces shall be necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment and/or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the campus.
2. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Cal Poly ITS Telecomm group representative is obtained. If permission is granted, perform this work in a manner acceptable to the Cal Poly ITS Telecomm group representative.
3. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
4. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required.

Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the campus.

E. Cleaning Up

1. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.
2. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.
3. All telecommunications infrastructure equipment spaces shall be thoroughly vacuumed and wiped clean prior to bringing online and at the completion of the project. Equipment shall be

opened for observation by the Cal Poly ITS Telecomm group representative as required.

F. Delivery, Drayage and Hauling

1. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.
2. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc. at no additional cost to the University.

G. Equipment and Material Protection

1. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the University.
2. It is the contractor's responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc.
3. Provided adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

3.02 QUANTITIES

- A. N/A

3.03 INSTALLATION

A. Mounting Heights

1. Mounting heights shall conform to ADA requirements.
2. Contractor responsible for the physical mounting of devices must have knowledge and understanding of ADA requirements.
3. Mounting heights shall be from floor to center of outlet, unless otherwise noted. Verify exact locations and mounting heights with the Project Manager before installation.
4. Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to the operating mechanism.

B. Waterproofing

1. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Contact the Cal Poly ITS Telecommunications group representative and the Cal Poly Facilities Project Manager and obtain written permission from the Cal Poly Facilities Project Manager before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
2. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the University.

C. Supports

1. Support work in accordance with the strictest manufacturer written recommendation per code or the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
2. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in telecommunications closets and equipment rooms.
3. Provide supporting frames or racks for equipment, which is installed in a freestanding position meeting Seismic Zone 4 requirements.
4. Supporting frames or racks shall be plumb and square with parallel side rails of standard angle, standard channel, or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
5. Adequate support of equipment (including faceplate, back, pull and junction boxes and fittings) shall not depend on electric conduits, raceways, or cables for support.
6. Telecommunications equipment shall not rest on or depend for support on suspended ceiling media. Provide independent support of telecommunications equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
7. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. Telecommunications equipment and supports shall not come in contact with work of other trades.

D. Fastenings

1. Fasten equipment to building structure in accordance with the strictest manufacturer written recommendation, per code or the best industry practice and while meeting Seismic Zone 4 requirements.
2. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:
 - a. Wood: Wood screws.
 - b. Concrete and solid masonry: Bolts and expansion shields.
 - c. Hollow construction: Toggle bolts.
 - d. Solid metal: Machine screws in tapped holes or with welded studs.
 - e. Steel decking or sub-floor: Fastenings as specified below for applied weights more than 100 pounds.

- f.
3. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
 - a. At concrete slabs provide 24-inch x 24-inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
 - b. At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods.
 - c. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
 4. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of the Cal Poly ITS Telecomm group representative and conform to the following as a minimum:
 - a. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
 5. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
 6. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.
- E. Equipment pads and Anchor Bolts
1. Provide concrete pads under all floor-mounted telecommunications equipment where specifically required by the Specifications or shown on the Drawings. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 1-inch margin around the equipment and supports. Pads shall be a minimum of 4 inches high and made of a minimum 28 day, 2500psi concrete reinforced with 6 inch x 6 inch 6/6 gauge welded wire mesh. Trowel tops and sides of pad to smooth finishes, equal to those of the floors, with all external corners bull-nosed to a ¼ inch radius. Shop drawings stamped NO EXCEPTIONS NOTED shall be used for dimensional guidance in sizing pads.
 2. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
 3. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an alternative, the mounting screws may pass through the gypsum board and be securely attached to 6 inches square, 18 gauge galvanized metal back plates, which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

3.04 GROUNDING & BONDING

- A. See individual sections for specific details.
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract Closeout. Complete any adjustments and/or alterations, which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. Refer to Specification Section 27-08-13 and 27-08-23 for extent of testing required.
- B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field-testing will be performed. Submit completion schedule for review within six months after the notice to proceed by Cal Poly ITS Telecomm group Representative has been given. Update this schedule periodically as the project progresses.

3.06 ACCEPTANCE

- A. Perform all tests required by local authorities, in addition to tests specified herein.
- B. Technicians shall be ready with all necessary tools, test equipment, and supplies necessary to troubleshoot and correct cabling system faults.
- C. Upon receipt of the Contractor's documentation of cable testing, the Cal Poly ITS Telecomm group representative will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative will notify the Contractor or Cal Poly Project Manager in writing.
- D. Specific system acceptance requirements are listed in the appropriate specification section.
- E. Final Punch List
 - 1. Prior to the Final Punch list, certify that systems and equipment are complete, operational, and are in compliance with the Contract Documents.
 - 2. Any deficiencies noted on the Final Punch list shall be expeditiously corrected and certified in writing.
- F. Operating and Maintenance manuals
 - 1. Provide Operating and Maintenance Manuals and Training of maintenance personnel for equipment and materials furnished under each Division.
 - 2. Maintenance manuals shall include complete cleaning and servicing data compiled in a clear and easily understandable format. Show model numbers of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. Record dimensions clearly and accurately to delineate the work as installed; suitably identify locations of all equipment by at least two dimensions to permanent structures. In addition, mark the Record Drawings to show the precise location of concealed work and equipment, including concealed or embedded raceways.
- B. and cables and all changes and deviations in the telecommunications infrastructure work form that shown on the Contract Documents. This requirement shall not be constructed as authorization to make changes in the layout or work.
- C. In a neat and accurate manner, provide a complete record of all revisions of the original drawings, as actually installed. The cost for these documents shall be included in the Contract. Submit drawings in AutoCAD and PDF format on CD for review. After review, make necessary changes to documents and then deliver 3-CD copies of them to the Cal Poly ITS Telecomm group representative.
- D. 3 copies of the final record drawings shall be submitted in AutoCAD and PDF format on CD.
- E. Submit 3 copies of the as-built telecommunications cabling schedules on CD as comma delimited ASCII format files (or other mutually acceptable media and format).

END OF SECTION 27 00 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
1. Install a telecommunication's grounding and bonding infrastructure.
 2. Grounding shall extend from the vault system to the TMGB.
 3. Grounding shall extend from the main building grounding bus bar to the TMGB.
 4. Bonding of all ladder rack segments, conduit, pull boxes, junction boxes, equipment racks/frames for use in support of the telecommunications infrastructure. All bonding and grounding shall terminate on the ground bar in the nearest EF/TR/ER.
 5. Bond all metallic/armored cable sheaths and associated protectors to the ground bars in each EF/TR/ER.
 6. Bond all Vaults, Manholes, Pull Holes and Pull Boxes to the common grounding system.
 7. All ground wires shall be terminated using the proper two-hole, compression type, copper lugs.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
1. Shop drawings shall show the locations where grounding backbone conductors are to be run and where they are to be attached to ground bars (TGB and TMGB) within each EF/TR/ER.
- C. Submit the complete list of materials proposed for this work in accordance with Section 27 00 00.
- D. Submit Manufacturer's Cut Sheets for the following:
1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Each backbone grounding conductor larger than #6 AWG shall be labeled with its far end destination at every instance where it attaches to a ground bar or ground rod. Labels shall be outdoor rated, 1" wide, nylon labels with black lettering at each endpoint and in each manhole or pull box.
- B. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. The Bonding Conductor for Telecommunications (BCT): The BCT shall bond the TGB to TBB, and bond the TMGB to the service equipment (building main power) ground.
- B. The Telecommunications Main Grounding Busbar (TMGB): The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB also serves as the central attachment point for telecommunications bonding backbones (TBB) and equipment, and is located such that it is accessible to telecommunications personnel.
- C. The Telecommunications Grounding Busbar (TGB): The TGB is the common central point of connection for telecommunications systems and equipment in the location served by that TR/ER.
- D. The Telecommunications Bonding Backbone (TBB): A TBB is a conductor that interconnects all TGB's with the TMGB. A TBB's basic function is to reduce or equalize potential differences between telecommunications systems bonded to it. A TBB is not intended to serve as the only conductor providing a ground fault current return path.
- E. The Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC): Whenever two or more vertical TBBs are used within a multistory building, the TBB shall be bonded together with a TBB interconnecting bonding conductor (TBBIBC) at the top floor (at a minimum).

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 METALLIC CABLE SPECIFICATIONS

- A. Ground Wire for Telecommunications Backbone (TBB):
 - 1. Non-Insulated grounding wire with a minimum conductor size of Number 3/0 AWG copper wire (or as indicated on drawings).
 - 2. Wire must be UL listed.
- B. Bonding Conductor for Telecommunications (Bonding the TGB to the TBB):
 - 1. Insulated grounding wire with a minimum conductor size of Number 1/0 AWG copper wire, with PVC insulation.

2. Must be UL listed.
 3. Cable jacket marking: Must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Copper Conductor Gauge.
 - c. UL listing.
 4. Cable jacket shall be green with black lettering.
- C. Ground Wire for connections within an EF/TR/ER:
1. Insulated grounding wire with a minimum conductor size of Number 6 AWG copper wire, with PVC insulation.
 2. Must be UL listed.
 3. Cable jacket marking: Must be legible and shall contain the following information:
 - a. Manufacturer's name.
 - b. Copper Conductor Gauge.
 - c. UL listing.
 4. Cable jacket shall be green with black lettering. **(See Fig. #140 in Appendix B)**
- D. Ground Wire for connections underground
1. Non-Insulated stranded grounding wire with a minimum conductor size of Number 2 AWG copper wire.
 2. Must be UL listed.

2.03 COMPRESSION LUG CONNECTORS

- A. Compression Lug Connector (Attaching #6 AWG ground wire to TGB or TMGB):
1. Copper Two-Hole Lug, Straight Long Barrel
 2. 1/4" Bolt Size, 5/8" Hole Spacing
 3. Twin clamping elements for cable; two holes for attachment to grounding bar, etc.
 4. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.
- B. Compression Lug Connector (Attaching #6 AWG ground wire to Conduits, Racks, Cable Runway, Cable Tray, other Grounded Telecom room elements):
1. Copper Two-Hole Lug, Straight Long Barrel
 2. 3/8" Bolt Size,
 3. Twin clamping elements for cable
 4. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.
- C. Compression Lug Connector (Attaching #1/0 AWG or larger ground wire to TGB or TMGB):
1. Copper Two-Hole Lug, Straight Long Barrel
 2. 3/8" Bolt Size, 1" Hole Spacing
 3. Twin clamping elements for cable; two holes for attachment to grounding bar, etc.
 4. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.

- D. Compression Lug Connector (Attaching #3/0 AWG or larger ground wire to TGB or TMGB):
 - 1. Copper Two-Hole Lug, Straight Long Barrel
 - 2. 3/8" Bolt Size, 1" Hole Spacing
 - 3. Twin clamping elements for cable; two holes for attachment to grounding bar, etc.
 - 4. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.
- E. Cable to cable connector: Heavy duty, permanent connection by exothermic weld between two or more copper conductors (#2 AWG and larger); splice "T" or cross, as indicated on the drawings and as required.
 - 1. Exothermic Welding reusable graphite mold for Cable to Cable Connection.
 - 2. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.

2.04 BUSBARS

- A. TMGB (Telecommunications Main Grounding Busbar)
 - 1. The TMGB shall
 - a. Be a predrilled copper busbar provided with holes for use with standard sized lugs.
 - b. Have minimum dimensions of ¼ in. thick x 4 in. wide x 20 in. long.
 - c. Be UL listed or by another nationally recognized testing laboratory.
 - d. Provided with insulators to electrically isolate busbar from mounting surface.
 - e. Provided with a minimum of 2 in. clearance from wall or other mounting surfaces for access.
 - f. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 27 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - 2. Approved Manufacturer: Chatsworth or Cal Poly ITS Telecomm group approved equal.
- B. TGB (Telecommunications Grounding Busbar)
 - 1. The TGB shall
 - a. Be a predrilled copper busbar provided with holes for use with standard sized lugs.
 - b. Have minimum dimensions of ¼ in. thick x 2 in. wide x 12 in. long
 - c. Be UL listed or by another nationally recognized testing laboratory.
 - d. Provided with insulators to electrically isolate busbar from mounting surface.
 - e. Provided with a minimum of 2 in. clearance from wall or other mounting surfaces for access.
 - f. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 lugs with 5/8" (15.8 mm) hole centers and 3 lugs with 1" (25.4 mm) hole centers.
 - 2. Approved Manufacturer: Chatsworth or Cal Poly ITS Telecomm group approved equal.

2.05 GROUND RODS

- A. Ground Rod (In Underground Vaults & Manholes)
 - 1. Solid copper clad steel

2. 3/4" diameter by 10' length
- B. Ground Rod (In Underground Pull Holes & Pull Boxes)
 1. Solid copper clad steel
 2. 5/8" diameter by 8' length
- C. Ground Rod Attachment
 1. Exothermic Welding reusable graphite mold for Cable to Ground Rod Connection.
 2. Terminate Cable to Ground Rod, #2 AWG to Rod 3/4"
 3. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. The Contractor shall install each ground conductor (wire) as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the installation specifications. There shall be no splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein.
- B. Unless otherwise noted, all ground wires shall be routed through the telecommunications cable management pathways so as to achieve a "coupled bonding conductor" effect.
- C. Do not install ground bars until after their installation location has been approved by the Cal Poly ITS Telecomm group representative.

3.02 QUANTITIES

- A. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Cable & Wire Installation
 1. Required Grounding Connections:
 - a. Provide and install one individual #6 AWG ground wire from each equipment rack/frame (installed under this work) to the TGB in the room. **Each conductor is to be "home run"; do not "daisy chain" the connections, unless specifically indicated on the drawings.**
 - b. Provide and install one individual #6 AWG ground wire from the overhead cable runway (installed under this work) to the TGB in the room.
 - c. Install one individual #6 AWG ground to each cable tray entering room.
 - d. Install one individual #6 AWG ground to each cable shielded termination. e. Install one individual #6 AWG ground to each entrance protector.
 - e. Install one individual #6 AWG ground to each metal conduit or sleeve.
- B. Busbar Installation

1. Wall-Mount Busbars
 - a. Attach busbar to the wall with appropriate hardware according to the Manufacturer's Installation Instructions.
 - b. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs, with lock washers, sized to fit the busbar and the conductors.
 - c. The Wall mount Busbar assembly shall be mounted @ 18" AFF, on the wall perpendicular to the rack row farthest from the entry door and close to or in a corner. (See the Fig. # 148 in Appendix B)
2. Ground Terminal Block
 - a. Every rack and cabinet shall be separately bonded to the MGB or TGB.
 - b. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack, installed on the rear of the rack, at the top, according to manufacturer recommendations.
 - c. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

3.04 GROUNDING & BONDING

- A. See appropriate sections of this document for details.

3.05 TESTING

- A. The Contractor shall test all metallic wires and cables installed under these Specifications.
- B. ***Using a multimeter, test continuity of each system element to ground (TGB or TMGB) for a maximum resistance of 1Ω.***

3.06 ACCEPTANCE

- A. Upon receipt of the Contractor's documentation of testing, the Cal Poly ITS Telecomm group representative will review/observe the installation and may randomly request tests of the cables/wires installed. Once the testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or the Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

END OF SECTION 27 05 26

SECTION 27 05 33 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Conduit and boxes in accordance with the Contract Documents.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES AND STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standard in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Coordinated conduit layout drawings, 1/8-inch scale, minimum. Show routing of all telecommunications conduits.
 - 2. Show locations of all telecommunications pull or termination (faceplate) back boxes.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Label both ends of any conduit 2" or larger noting destination.
- B. Refer to Section 27 05 53 for additional details.
- C. Cal Poly ITS Telecomm group Labeling, Design and Syntax Standard in Appendix B.

1.06 DEFINITIONS

- A. All conduit and pull boxes shall be sized to allow for a future cable plant expansion of 25%.
- B. All pathways are to be continuous, accessible, viable and useable upon completion of construction.
- C. Minimum conduit size for communications conduit is 1 ¼ ".

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 CONDUIT AND FITTINGS (with bushings on all ends)

- A. Rigid Metal Conduit (RMC):
1. Rigid conduit, heavy wall, threaded ends.
 2. Threaded type fittings.
- B. Intermediate Metallic Conduit (IMC):
1. Rigid conduit, thinner wall, threaded ends.
 2. Threaded type fittings.
- C. Electrical Metallic Tubing (EMT):
1. Continuous, seamless steel tubing galvanized or sherardized on exterior, coated on interior with smooth hard finish of lacquer, varnish or enamel.
 2. Steel, set screw or compression type fittings. Provide concrete type fittings where required.
- D. Rigid Non-metallic Conduit (PVC):
1. Schedule 40 polyvinyl chloride suitable for 90° C.
 2. Solvent cemented type fittings.
- E. Insulated Grounding Bushings for Rigid Metal Conduit and Intermediate Metallic Conduit and Electrical Metallic Tubing:
1. Shall be constructed of malleable iron.
 2. Shall have a plastic insulated throat.
 3. Shall have set screws.
 4. Shall have a bronze lay-in type lug.
 5. Approved Manufacturer (Threaded): Appleton or Cal Poly ITS Telecomm group approved equal
 6. Approved Manufacturer (Threadless): Appleton or Cal Poly ITS Telecomm group approved equal
- F. Fittings for Threadless Rigid Metal Conduit (RMC) or Intermediate Metallic Conduit (IMC):
1. Shall be constructed of malleable iron, zinc plated.
 2. Shall have a plastic insulated throat.
 3. Shall be compression type.
 4. Shall be UL listed water and concrete tight.
 5. Approved Manufacturer: American Fittings Corp or Cal Poly ITS Telecomm group approved equal
- G. Fittings for Electrical Metallic Tubing (EMT):
1. Shall be constructed of steel, zinc plated.
 2. Shall have a plastic insulated throat.

3. Shall be compression type.
4. Shall be UL listed water and concrete tight.
5. Approved Manufacturer: American Fittings Corp or Cal Poly ITS Telecomm group approved equal

2.03 BACK AND PULL BOXES

- A. Cast Type Boxes (Weatherproof, Surface mount):
 1. Universal Box with mounting lugs, two closure plugs and ground screw.
 2. Tapered threads for hubs.
 3. Material-Die Cast Aluminum with Aluminum lacquer finish.
 4. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal
- B. Cast Type Box Cover (Weatherproof, Surface mount):
 1. Cast raised cover; size matched to contour of box.
 2. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal
- C. Galvanized Pressed Steel Type Boxes (Indoor Station Back Boxes):
 1. Pressed steel, galvanized or cadmium-plated.
 2. 4-11/16 inch square by 2/1/8 inch deep minimum with 1 1/4 " knockout.
 3. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.
- D. Mud Ring for Galvanized Pressed Steel Type Boxes (Indoor Station Back Boxes w/ 6 or less data outlets):
 1. 4-11/16" pre-galvanized steel square box device cover, 5/8" raised, 3 cu in.
 2. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.
- E. Mud Ring for Galvanized Pressed Steel Type Boxes (Indoor Station Back Boxes w up to 8 data outlets):
 1. 4-11/16" pre-galvanized steel square box device cover, 5/8" raised, 6.3 cu in.
 2. Approved Manufacturer: Thomas & Betts or Cal Poly ITS Telecomm group approved equal.
- F. Sheet Steel Boxes (Pull Boxes):
 1. No. 12 gauge sheet steel for boxes with maximum side less than 40 inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.
 2. No. 10 gauge sheet steel for boxes with maximum side 40 to 60 inches, and maximum area 1,000 to 1,500 square inches; riveted or welded 3/4 inch flanges at exterior corners, with hinged covers if clearance allows.
 3. No. 10 gauge sheet steel riveted or welded to 1 1/2" by 1 1/2" by 1/4" welded angle iron framework for boxes with maximum side exceeding 60 inches and more than 1,500 square inches in area, with hinged covers if clearance allows.
 4. Covers:
 - a. Same gauge steel as box.

- b. Hinged covers if clearance allows else subdivided single covers so no section of cover exceeds 50 pounds.
- c. Machine bolts or machine screws threaded into tapped holes.
- 5. Paint:
 - a. Rust inhibiting primer, ANSI 61 grey enamel finish coat.
- 6. Manufacturer/Product: None Specified – Make Submittal

2.04 FLOOR BOXES AND FITTINGS

- A. Recessed Floor Box:
 - 1. Floor boxes and fittings shall be suitable for the fire rating and thickness of the floor and for the types and quantity of telecommunications SCS to be installed through the device.
 - 2. Lid or cover must have the ability to close completely while allowing cables to exit the box without compression or damage.
 - 3. See Section 27 15 43, 2.08 for additional detail.
 - 4. Each box shall have a minimum of one 1 ¼" knock out.
 - 5. Approved Manufacturer: Legrand/Wiremold Evolution Series Floor Box (EFB) or Cal Poly ITS Telecomm group approved equal

2.05 INNERDUCT

- A. Fiber Optic Innerduct
 - 1. 1 ¼" Single Fiber Innerduct (For 4" OSP Conduit, 4 required) with included mule tape.
 - 2. Orange in color

PART 3 – EXECUTION

3.01 GENERAL

- A. Provide conduit and pull boxes for all telecommunications cabling routed outside of TRs or ERs. **All conduit and pull boxes shall be sized to include an additional 25% capacity for future expansion.**
- B. No cable hangers (J-Hooks, Bridle Rings, Bat Wings, Etc.) shall be used.
- C. Horizontal pathways shall follow building lines and shall be accessible for future reentry.
- D. **All pathways shall be firestopped with re-enterable firestopping at rated assemblies.**
- E. Locate conduits so that the integrity of structural members is not affected and they do not conflict with the services of other trades.
- F. Except where other specific sizes are required by the Contract Documents, the minimum size for telecommunications conduits shall be:
 - 1. Four 4 inch (4") conduits for backbone pathways. Four inch conduits shall also be used between the telecommunications entrance facility (EF) and the equipment room (ER), and between ERs and TRs on the same floor of a multi-story building.
 - 2. One and a quarter (1-1/4") inch where a conduit serves a maximum of one typical faceplate.

G. CONDUIT FILL

1. Maximum cable count in conduit (conduit fill) to avoid exceeding maximum pull tension limitations:

(Sleeve < 2') / (Straight < 100') / (Two 90° Bends & > 100')

Conduit Size	Cat5e .205"	CAT 6 .231"	CAT 6A .285"
¾"	N/A	N/A	N/A
1 ¼"	19 / 12 / 9	13 / 8 / 6	10 / 6 / 5
2"	48 / 32 / 24	32 / 21 / 16	25 / 16 / 12
4"	190 / 127 / 95	128 / 86 / 64	98 / 65 / 49

3.02 QUANTITIES

- A. Quantities of conduits, pull boxes, etc. shown on the drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

A. Conduit

1. **Where accessible cable tray is installed, conduit must extend continuously to and must mechanically attach, or be bonded to, the cable tray.**
2. Conduit must extend no further than 2 inches into the cable tray.
3. **All conduits are to have insulated throat bushings.**
4. **Throat bushings shall have grounding lugs unless mechanically attached to cable tray.**
5. **All conduits are to be continuously bonded back to the TGBB in the EF/ER/TR.**
6. Draw up couplings and fittings full and tight. Protect threads from corrosion after installation with zinc chromate or equivalent protection.
7. Conceal conduits except at surface mounted cabinets and freestanding equipment. Install minimum of 6 inches from flues, steam pipes, or other heated lines. Provide flashing and counter-flashing for waterproofing of raceways that penetrate the roof. Do not penetrate waterproof membranes unless proper seal is provided and permission is given.
8. Install telecommunications conduit a minimum of 24 inches from parallel power raceways; avoid long parallel runs of telecommunications and power conduits to the extent practicable. When crossing power raceways, cross at a 90° angle.
9. Install telecommunications conduit a minimum of 12 inches from florescent lighting fixtures.
10. Route exposed conduits and conduits above suspended ceilings parallel or perpendicular to building lines with right angle turns and symmetrical bends. Provide sleeves in concrete walls, floor slabs and partitions. Waterproof sleeved conduits where required.

- 11. Provide conduit expansion joints for exposed and concealed conduits at expansion joints between structures to compensate for differential movement and where necessary to compensate for thermal expansion/contraction. Provide bonding conductor.**
 12. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceilings or floors which separate adjacent rooms having substantially different maintained temperatures, refrigeration, or being used as cold storage rooms.
 13. Provide conduit seal-offs where portions of an exterior raceway system pass into a building.
 14. Conduit seals shall be vapor proof.
 - 15. Provide ¼" nylon pull rope with 600 lb. pulling tension in every conduit 2" or larger.**
 - 16. Provide pull string with 210 lb. pulling tension in every conduit smaller than 2".**
 - 17. All conduits must have a pull string/rope, including after placement of cabling.**
 18. Secure conduit clamps or supports to masonry materials with toggle bolts, expansion bolts, or steel inserts. Install conduit on steel construction with approved clamps which do not depend on friction or set-screw pressure alone.
 19. The minimum 90-degree bend radius for conduit is 6 times the internal diameter of the conduit (10 times the internal diameter if conduit larger than 2 inches).
- B. Conduit above Suspended Ceilings
1. Provide independent support of all conduits. Provide UNISTRUT support and threaded rod to structure above. **Attachment to ceiling support wires is not permitted.**
 - 2. Install conduit a minimum of 1 foot above top of suspended ceiling.**
- C. Conduit in floor slabs
1. Conduits runs for horizontal cabling shall not be installed below a building's slab, however they may be installed within the slab with the approval of the Structural Engineer.
 2. Conduits shall not interfere with placement of floor slab reinforcement components.
 3. Install conduits between the upper and the lower layers of reinforcing steel.
 - 4. Space conduits not less than 8 inches on centers except where they converge at telecommunications backboards, equipment cabinets or junction boxes.**
 5. Conduits running parallel to slabs supports, such as beams, columns and structural walls, shall be installed not less than 12 inches from such supporting elements.
 6. Elbows used for stub ups on conduit installed below grade or embedded within floor slabs shall be rigid steel conduit with two coats of corrosion resistant paint or tape wrap.
 7. Tie embedded conduits securely in place prior to concrete placement. **Conduits installed within floor slabs shall extend a minimum of 4 inches above the finished slab to a maximum of 6 inches above the finished slab or housekeeping pad to the first connector.**
 8. **Conduits embedded in a slab shall have a dedicated pull box within 1' of their stub up.**
 9. Pathways embedded below the slab must be continuous from the faceplate location

to the EF/TR/ER.

10. Conduit stub ups must enter the room no more than 3" from a finished surface of a wall.

D. Conduit in hazardous locations

1. Provide conduit with appropriate seal-offs, explosion-proof fittings, etc. in special occupancy areas as required.
2. Conduits and fittings installed in hazardous (classified) locations shall conform to NEC Article 500 requirements for the associated Class and Division.

E. Non-Metallic Conduit

1. Joints shall be made using the material recommended by the conduit manufacturer. Components shall be cleaned prior to assembly.
2. Conduit cutoffs shall be square and shall not deform conduit. Ream rough surfaces.
3. Provide male box adapters to terminate conduits.
4. Where separable terminations are required, provide PVC threaded adapters with locknuts or bushings. Provide "O" rings for watertight installations.
5. **All bends must be factory manufactured.**
6. **Provide expansion fittings where required.**
7. **Conduit supports shall be installed to allow non-metallic conduit to slide through the supports.**

F. Back-Boxes

1. Provide back boxes and pull boxes as indicated and as required for a complete installation and to facilitate proper pulling of wires and cables.
2. Boxes shall be sized per ANSI/TIA/EIA-569-A as minimum. (For single conduits trade size 1-1/4 inch, or smaller, a back-box sized 4-11/16 inch square by 2-1/4 inch deep may be used as a pull box, UON.) **Plug open knock outs.**
3. The exact location of back boxes and equipment is governed by field conditions. Where necessary, relocate back boxes so that fixtures and equipment are symmetrically located in accordance with the room layout and will not interfere with other work or equipment. Verify final location of back boxes, fixtures, and equipment with Architect.
4. **Back-to-back back boxes in the same wall, or "through-wall" type boxes are not permitted. (See Fig. #158 in Appendix B)**
5. Fit back boxes in finished ceilings or wall with appropriate covers, set flush with the finished surface. Provide box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide a plaster ring.

G. Pull Boxes

1. Pull boxes shown in the Drawings are generally a minimum requirement that assumes the conduit run shall be the length indicated and there shall be no more bends than indicated. Actual site conditions and field coordination with other trades usually result in additional bends in the conduit and sometimes cause the length of the run to be greater than shown. Therefore, install pull boxes in all telecommunications conduit runs so that the following conditions are met:

- a. **Install pull boxes as required in conduit runs so that the distance between pull points is less than 100 feet.**
- b. **Install pull boxes in conduit runs so that a run of conduit does not contain more than the equivalent of two (2) ninety-degree bends (180 degrees total) between pull points.**
- c. For reverse bends (between 100 and 180 degree), Insert a pull box at each bend.
- d. Pull boxes shall only be installed in straight sections of conduit, not in lieu of a bend.
- e. **Each conduit entering and exiting a pull box shall be in direct alignment. (See Fig. #158 in Appendix B)**
- f. **Do not use "Condulet" type fittings in runs of telecommunications conduit.**
- g. Pull boxes shall not be installed in restrooms, locker rooms or other similar facilities.
- h. Pull boxes larger than 18" square shall not be installed above hard ceilings.
- i. Pull boxes less than 18" square can be installed above hard ceilings provided an appropriately sized access hatch is installed.
- j. Pull boxes shall not be located in floors.
- k. Pull boxes shall include screws for each cutout in the cover plate.
- l. Pull boxes larger than 24" in any dimension shall have a hinged lid(s).
- m. **When a Structured Cable System cable bundle enters a pull box from a conduit, the same bundle shall exit the box in a single conduit without splitting off any cables from or adding any cables to, the bundle. NO DAISY-CHAINING OF PULL BOXES SHALL BE ALLOWED. (See Fig. # 159 in Appendix B)**

H. Pull Box Sizing

1. Pull Box serving a Single Faceplate
 - a. For a pull box serving a single faceplate, a 4 11/16" box, 2 1/4" deep box is required.
2. Pull Box serving Horizontal Cabling
 - a. For a pull box serving a single conduit the length shall be 8 times the diameter of the conduit, width shall be 4 times the diameter and the depth shall be 2.5 times the diameter of the conduit. For each additional conduit of the same size, increase the width of the pull box by 2.5 times the diameter of the conduit.
 - b. For a single 1 1/4" conduit, minimum pull box size shall be 10" x 6" x 3" (LxWxD)
 - c. For two 1 1/4" conduits, minimum pull box size shall be 10" x 9" x 3"
3. Pull Box serving Backbone Cabling
 - a. For a pull box serving a single conduit the length shall be 10 times the diameter of the conduit, width shall be 4 times the diameter of the conduit and the depth shall be 2.5 times the diameter of the conduit. For each additional conduit of the same size, increase the width of the pull box by 2.5 times the diameter of the conduit.
 - b. For a single 2" conduit, minimum pull box size shall be 20" x 8" x 5"
 - c. For a single 4" conduit, minimum pull box size shall be 40" x 16" x 12"

- d. For two 4" conduits, minimum pull box size shall be 40" x 26" x 12"
- I. Appropriate Application of Conduit
 1. Rigid Metal Conduit or Intermediate Metal Conduit:
 - a. Where potentially exposed to physical damage.
 - b. Indoors where exposed to damp or moist environments such as crawlspaces.
 - c. Where outside plant cable enters the building to the point where it terminates.
 - d. Exposed installations within 10 feet above finished grade.
 - e. Where required by code, particularly Section 800-40 of the NEC
 2. Electrical Metallic Tubing:
 - a. General purpose distribution of telecommunications cabling, except where another conduit type is specifically required.
 3. Rigid Non-Metallic Conduit:
 - a. Embedded in floor slabs.
- J. Appropriate Application of Back Boxes and Pull Boxes
 1. Cast Type Boxes:
 - a. Where connected to rigid metal conduit or intermediate metal conduit, 1¼ inches and smaller.
 - b. Exposed conduit installations within 10 feet above finished floor.
 - c. Where exposed to moisture and outdoors.
 2. Galvanized Pressed Steel Type Boxes:
 - a. Where connected to electrical metallic tubing, 1¼ inches and smaller.
 - b. Dry locations.
 - c. Where concealed in walls and above suspended ceilings.
 - d. ***The size for the typical back-box for wall mounted telecommunications faceplates shall be 4-11/16 inch square by 2-1/4 inch deep with a single gang plaster ring, UON.***
 3. Sheet Steel Boxes:
 - a. Where connected to conduit for use as a pull box.
 - b. Where used as a termination point for future cabling.
 - c. Where readily accessible.
- K. Innerduct
 1. All conduits where fiber optic cables are installed, with the exception of station fiber, are to use innerduct.
 2. Plastic Innerduct
 - a. Use plastic innerduct for any situations where a fiber optic cable is exposed within a building. Examples are to include transit from a cable tray or ladder racking.

- b. Follow all manufacturers' written instructions, specifically regarding use of a swivel.
- c. Refer to drawings and conduit schedules for conduits designated to be used for fiber optic cables.
- d. ***Each plastic innerduct is to carry a maximum of one fiber optic cable.***
- e. Use terminal adapters to connect to fiber distribution cabinets, and other endpoints.
- f. ***Any break in continuous innerduct shall be joined using a coupler.***
- g. Follow all manufacturers' written instructions.

3.04 GROUNDING & BONDING

- A. ***All metallic conduits are to be continuously bonded back to the TGBB in the EF/ER/TRs.***
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. ***For all conduits placed in the slab, use ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt or similar material to insure no blockages. This assembly shall be pulled with or ahead of cable being installed. Clean empty raceways similarly. Clear or replace any raceway which rejects ball mandrel.***
- B. Testing must be done in the presence of the Cal Poly ITS Telecomm group representative.

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all conduit 2" and larger, and their associated pull boxes.

END OF SECTION 27 05 33

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Telecommunications cable trays and accessories in accordance with the strictest manufacturer written recommendation, per code or the best industry practice.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27-00-00.
- B. NEMA VE-1 (Standard for Metal Cable Tray Systems)
- C. NUSIG (National Uniform Seismic Installation Guidelines)
- D. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings
 - 1. Coordinated cable tray layout drawings, 1/8- inch scale, at minimum. Show routing of all telecommunications cable tray.
 - 2. Show locations of related fire stops, expansion joints and connections to conduits or other pathways of similar size.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 3. Any products not specifically listed in the PRODUCTS section shall require submittal of the manufacturer's cut sheets and the system/product design approval of the Cal Poly ITS Telecomm group.
- D. Seismic restraint calculations for the cable tray and its supports shall be submitted and meet the criteria for Seismic Zone 4 installation.

1.05 IDENTIFICATION

- A. None Required

1.06 DEFINITIONS

- A. All pathways are to be continuous, accessible, viable and useable upon completion of construction.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 RIGID CABLE TRAY

- A. Cable tray shall be aluminum with solid corrugated flooring.
- B. The cable trays shall be NEMA Class Designation 12B (75 lbs. per linear foot) with a safety factor of 1.5.
- C. Cable tray systems shall consist of straight sections, fittings, and accessories as defined in NEMA VE-1, VE-2 and UL classified as equipment grounding conductors. Provide radiused elbows, tees, crosses, splice plates, wall and overhead supports, and other fittings necessary for a complete, continuously grounded system.
- D. Aluminum: Straight sections and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. Fabricated parts shall be made from Aluminum Association Alloy 5052. Splice plates shall be of wedge lock design, using four square neck carriage bolts and serrated flange locknuts.
- E. ***The cable trays shall be a minimum of eighteen inches (18") wide by a minimum of 3" deep, unless otherwise noted on the drawings.***
- F. The tray shall be equipped with elbows, tees, and other attachments as required to complete the installation following a single manufacturer's guidelines.
- G. Approved Manufacturer: Cope Trof or Cal Poly ITS Telecomm group approved equal

2.03 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings shall be of the same materials and finishes as cable tray, and from the same manufacturer.
- B. Provide cable tray trapeze supports and connectors including bonding jumpers, as required by cable tray manufacturer.
- C. Cable tray fittings that are used for changing of direction or elevation shall be factory made expressly for that purpose. No field improvised fittings are to be used.

Cal Poly ITS Telecomm Group CABLE TRAY OPTIONS IN ORDER OF ACCEPTABILITY

When proposing cable tray options to fit a specific limited space installation need, the following is the order of product type acceptability:

1. The most desirable cable tray product for Cal Poly ITS Telecomm use is 18" wide, 3" high (sides), solid bottom, corrugated, aluminum cable tray as offered by Cope Trof or approved Cal Poly ITS Telecomm group equal. The information can be found using the following link.
<http://www.copecabletray.com>
2. In locations where traditional solid channel style cable tray will not work due to limitations of the space needed to be worked in, this "whale bone" style tray is the second choice of the Cal Poly ITS Telecomm group. Information regarding one acceptable manufacturer's product can be found at the following link. Submit data sheets for all products for approval by the Cal Poly ITS Telecomm group.
http://www.cooperindustries.com/content/dam/public/bline/Resources/Library/catalogs/cable_tray_systems/all_products/Cent-R-Rail.pdf
3. Snake Tray, or a Cal Poly ITS Telecomm approved equal is to be considered for use in situations where there is limited vertical space and restricted or random tray access. For information regarding Snake Tray, Mega Snake, Snake Canyon, Snake Race Ways and MC Snake Tray use the following link. <http://www.snaketray.com/cable-management/>

PART 3 – EXECUTION

3.01 GENERAL

- A. Coordinate location of cable trays with other trades to avoid conflicts and maintain accessibility.
Where installed above an accessible ceiling, cable trays shall be not less than 12 inches above the bottom of the finished ceiling. Vertical clearance above the tray shall be a minimum of 12 inches; clearance to at least one side of the cable tray shall not be less than 3 feet.
- B. Conduit entries and all other transition points shall only occur in accessible locations.

3.02 QUANTITIES

- A. Quantities of cable trays and associated accessories shown on the drawings are illustrative only and shall be meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Cable tray shall be one continuous structure, and installed level.
- B. All transitions shall use radiused fittings.
- C. Install cable tray so that it is accessible: Installation in open ceiling areas and above lay-in accessible ceilings shall generally be acceptable. Installation above "hard" ceilings, within a chase, behind a wall or where obstructed by ducts, pipes, etc. shall not be acceptable.
- D. ***Where the cable tray crosses an inaccessible area, place a minimum of four 4" conduits to connect the accessible segments together. The 4" conduits must extend a minimum of 12" beyond the edge of the inaccessible area on both sides.***

1. Exception: Relatively short (10 foot maximum) straight sections (no transitions) of cable tray may be routed over hard ceilings or through similar inaccessible areas provided that good access to the cable tray is maintained at both ends of the short inaccessible run.
- E. Where conduits are used in lieu of a section of cable tray, they shall join the cable tray from the end at an equal height, not from the side or above. Transitions of this type shall require the use of a "Straight Reducer Fitting".
- F. Install expansion joints and related fittings where required to accommodate the expected environmental ambient temperature range of 50 to 80 degreesF.
- G. Each end of the tray shall be equipped with a finished lip and drop off to reduce damage to cables.
- H. Manufactured offsets shall be used to change height or direction of rigid cable trays. Cable tray vertical transitions or transitions from a cable tray to other pathways must be designed such that unsupported cable does not exceed 2 feet.
- I. Cable tray offsets shall utilize 30 degree angles, and distance between transitions shall be no less than two times the offset distance.
- J. Cable trays are to be clean and debris free before the placement of cable.
- K. Firestop System
 1. Where cable tray encounters a fire rated assembly (wall, floor, shaft, etc.), install a listed Firestop system to maintain the fire rating of the assembly. Firestop systems must be of a re-entenable type and equal in area/capacity.
 2. All Firestop systems must be accessible for future maintenance.
 3. See Section 27 05 37 for further detail.
- L. Support
 1. Rigid cable tray shall be supported at distances not to exceed the maximum required for the specified NEMA Load/Span Designation(s) and at each bend, tee, cross, and elbow fitting.
 2. Supports shall be 3/8" threaded rod trapeze style hangers, threaded rods with rail clips as recommended by the cable tray manufacturer and as suitable for the specified cable tray NEMA Load/Span Designation.
 3. Side rails shall bear on the supports; rungs shall not bear on the supports.
 4. Cable tray supports shall not be used to mount any other structures.
 5. Provide seismic restraints/supports as required. (Seismic Zone 4)

3.04 GROUNDING & BONDING

- A. ***Cable tray shall be electrically continuous. Where a cable tray run is interrupted at a fire rated assembly, an expansion joint or is otherwise rendered electrically discontinuous, provide bonding jumpers.***
- B. ***Where cable tray enters a telecommunications closet or equipment room, bond the cable tray to the TGB in that room.***
- C. Where conduits or other conductive raceways connect to a cable tray system, bond them together with connection suitable for the purpose.
- D. Refer to Section 27 05 26 for additional details.

3.05 TESTING

None Required

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all cable tray.

END OF SECTION 27 05 36

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SECTION 27 05 37 - FIRESTOPPING SYSTEMS FOR COMMUNICATIONS CABLING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
1. Firestop systems and installation as it relates to communications cabling.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. Provide Firestop systems that comply with the following requirements:
1. Firestop material shall be tested by a qualified testing and inspection agency (UL or comparable).
 2. Only Firestop products bearing the classification marking of qualified testing and inspection agency shall be used.
- C. Installation personnel shall be by qualified and trained. Acceptable Installer qualifications are as follows:
1. FM Research approved in accordance with FM AS4991.
 2. Individuals or staff who are certified, licensed, or otherwise qualified by the Firestop manufacturer as having the necessary training and experience.
 3. Minimum of 1 year experience in the installation of manufacturer's products is required.
 4. The Installers shall have been trained by a direct representative of the manufacturer (not a distributor or agent) in the proper selection and installation procedures.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. ASTM E 84, "Surface Burning Characteristics of Building Materials".
- C. ASTM E 119, "Fire Tests of Building Construction and Materials".
- D. ASTM E 814, "Fire Tests of Penetration Firestop Systems".
- E. ANSI/UL263, "Fire Tests of Building Construction and Materials".
- F. ANSI/UL723, "Surface Burning Characteristics of Building Materials".
- G. ANSI/UL1479, "Fire Tests of Through Penetration Firestop".
- H. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
- I. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.

- B. Shop Drawings:
 - 1. Indicate location of every communications firestop system, as well as which UL applications test applies.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require submittal and approval of the proposed manufacturer's cut sheets by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. ***At all installed locations, install a label on each side of the wall indicating the following information:***
 - 1. ***Manufacturer of Firestop***
 - 2. ***Name of product and UL System Number***
 - 3. ***Name of installation contractor and date of installation.***
 - 4. ***Rating of the wall/system.***
 - 5. ***Install labels prior to the Design Engineer's above-ceiling inspection.***
- B. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS:

- A. Communications cabling: Cabling to include telecommunications, data, coaxial, distributed antenna systems.
- B. Conduit sleeve: A conduit that only penetrates a single wall for the purpose of providing a pathway for communications cabling into adjacent rooms.
- C. Firestop Assembly: A manufactured product from a reputable company that is delivered to the contractor fully- or partially assembled and when installed is rated as meeting the UL 1479 or ASTM E814 standards for fire testing and becomes part of a Firestop System for that particular type of installation.
- D. Firestop System: A product or series of products from a reputable manufacturing company that when installed properly by the contractor meets the UL 1479 or ASTM E814 standards for fire testing for that particular type of installation.
- E. Zero maintenance firestop assembly: A firestop assembly with a self-contained sealing system which shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to adjust, remove or reinstall firestop material.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- B. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 ZERO-MAINTENANCE FIRESTOP ASSEMBLY

- A. Shall meet or exceed the ratings of the wall or floor that it penetrates.
- B. Shall be used for communications cabling at all interior wall penetrations through a single, fire-rated wall or floor.
- C. Shall be a listed (UL and/or FM) Firestop assembly system tested to UL 1479 or ASTM E814. The assembly size and quantity shall be determined as follows:
 - 1. For round openings, the fill ratio of cabling-to-opening-size shall not exceed 40%, or as dictated by the manufacturer, whichever is more stringent.
 - 2. For rectangular openings, the fill ratio of cabling-to-opening size shall not exceed 50%, or as dictated by the manufacturer, whichever is more stringent.
 - 3. Include in cabling cross-sectional area enough spare capacity to accommodate 25% growth while maintaining the fill percentages in #1 and #2 above. Upon commissioning, if adequate spare capacity is not observed, contractor shall install additional assemblies at their own cost to provide such spare capacity.
 - 4. Approved Manufacturer: Specified Technologies Inc., EZ Path Series 22, 33, or 44 or Cal Poly ITS Telecomm Group approved equivalent.

2.03 FIRESTOPPING FOR COMMUNICATIONS CONDUITS & OTHER APPLICATIONS

- A. Required for all fire-rated wall penetrations where a communications pathway extends beyond a single fire-rated partition.
- B. Required for all telecommunications outlets located in fire-rated walls. System shall be UL CLIV tested.
- C. Shall be a listed (UL and/or FM) Firestop assembly system tested to UL 1479 or ASTM E814.
- D. Shall meet or exceed the ratings of the wall or floor that it penetrates.
- E. Approved Manufacturers: 3M, Hilti, Specified Technologies Inc., or Cal Poly ITS Telecomm Group approved equivalent.

PART 3 – EXECUTION

3.01 GENERAL

- A. All firewall penetrations shall be sleeved, and Firestop applied. **(See Fig. #138 in Appendix B)**
- B. All conduits (empty, partly filled or full) terminating in a telecommunications space shall have Firestop applied using plug style Firestop muffins.
- C. Communications cable tray may be continued through a fire-rated wall providing that approval from the AHJ is granted. Otherwise, stop the tray, install multiple zero-maintenance firestop assemblies, and continue tray on the other side. Ensure grounding of the cable tray is continuous through the wall.
- D. Provide Firestop assemblies of a sufficient size to accommodate the capacity of the cable tray (including the 25% allowance for growth).

3.02 QUANTITIES

- A. Quantities of Firestop elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct

quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Schedule installation of Firestop for after completion of penetrating item installation, but prior to covering or concealing of openings.
- B. Before beginning installation:
 - 1. Examine effected surfaces, as they shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
 - 2. Provide masking and temporary covering to protect adjacent surfaces.
 - 3. Do not proceed until unsatisfactory conditions have been corrected.
- C. Do not install Firestop products when ambient or substrate temperatures are outside limitations recommended by the manufacturer.
- D. Do not install Firestop products when substrates are wet due to rain, frost, condensation, or other causes.
- E. Maintain minimum temperature before, during, and for a minimum of 3 days after installation of materials.
- F. Do not use materials that contain flammable solvents.
- G. Coordinate construction of openings and penetrating items to ensure that through penetration firestop systems are installed according to specified requirements.
- H. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- I. Install through-penetration firestop systems in accordance with the conditions of testing and classification as specified in the published design. Comply with manufacturer's instructions for installation of Firestop products.
- J. After installation:
 - 1. ***Remove equipment, materials, and debris, leaving area in undamaged, clean condition.***
 - 2. Clean all surfaces adjacent to sealed openings to be free of excess Firestop materials and soiling as work progresses.

3.04 GROUNDING & BONDING

- A. Ensure grounding of the any metal pathways is continuous through any Firestop.
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. Verify requirements with AHJ/SFM.

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. On shop drawings and record drawings, indicate location of every communications Firestop system, as well as which UL applications test applies.

END OF SECTION 27 05 37

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SECTION 27 05 39 - SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Surface Raceways and accessories
- B. Surface Raceways shall only to be used in facility remodels if deemed necessary and shall not to be used for new building/residential construction without the specific approval of the Cal Poly ITS Telecomm group. Surface Raceway may be specified for use in certain computer labs or office areas if the need is justified and the specific use is preapproved.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. UL 5 - Surface Metal Raceways and Fittings.
- C. UL 514A - Metallic Outlet Boxes.
- D. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
- E. Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Coordinated conduit layout drawings, 1/8-inch scale, minimum. Show routing of all surface raceways.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require submittal and approval of the proposed manufacturer's cut sheets by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. In accordance with the Cal Poly I.T.S. Telecomm group Labeling, Design and Syntax Standards in Appendix B.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 SURFACE RACEWAY

- A. Size according to Execution section.
- B. Approved Manufacturer: Legrand/Wiremold (*See Fig. #157 in Appendix B*) or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Use metal raceway whenever possible.
- B. All transitions in either the horizontal or vertical plane shall be fiber rated radiused fittings.
- C. Transitions shall have the same carrying capacity as the elements they connect.
- D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- E. Install all components necessary to make a complete, code-compliant, specification-compliant installation.
- F. All components used shall be employed in the manner intended by the manufacturer.
- G. Sections of surface raceway less than 7' in length shall be a single piece of raceway.
- H. Raceway Sizing (For undivided raceways): (Legrand/Wiremold Series for sizing)

# of Cat5e Cables	# of Cat6 Cables	# of Cat6A Cables	Surface Conduit
3	2	1	2800 or equal
1	7	3	2900 or equal
83	58	29	4000 or equal
47	33	16	5500 or equal

3.02 QUANTITIES

- A. Quantities of raceway elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and all relevant codes.

3.03 INSTALLATION

- A. Follow all manufacturers' written instructions.
- B. *Wall-mounted raceway shall be installed with adequate volume behind the jacks to allow required bend radii as well as sufficient cable pathway.***

3.04 GROUNDING & BONDING

- A. All metal surface raceways shall be properly bonded and grounded.
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. None Required

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. Show type and indicate all surface mounted conduit on project Drawings.

END OF SECTION 27 05 39

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SECTION 27 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Conduits, Ducts, and Duct Banks
 - 2. (Signal) Hand Holes (SPH)
 - 3. (Signal) Pull Boxes (SPB)
 - 4. (Signal) Vaults/Manholes (SMH)

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES AND STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. AASHTO HB 17 - American Association of State Highway and Transportation Officials, Standard Specifications for Highway Bridges, 17th Edition
- C. ANSI C80.1 – Galvanized Rigid Steel Conduit
- D. ANSI C1037 – Standard Practice for Inspection of Underground Precast Concrete Utility Structures
- E. ASTM A48/A48M – Standard Specification for Grey Iron Castings
- F. ASTM F512 - Standard Specification for Smooth-Wall PVC Conduit and Fittings for Underground Installation
- G. ASTM C857-95 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
- H. ASTM C858 – Standard Specification for Underground Precast Concrete Utility Structures
- I. ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures
- J. ASTM C 1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures
- K. Cal PUC G.O. 128 Rules for Construction of Underground Electrical Supply and Communications Systems, State of California Public Utilities Commission
- L. ISO 9000 – Quality Management Systems – Fundamentals and Vocabulary
- M. ISO 10012 – Measurement Management Systems, Requirements for Measurement Processes and Measuring Equipment
- N. NEMA TC2 – Electrical PVC Conduit
- O. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

- P. NEMA TC6&8 – PVC Plastic Utilities Duct for Underground Installations
- Q. NEMA TC9 – Fittings for PVC Plastic Utilities Duct for Underground Installations
- R. SCTE 77 - Specification for Underground Enclosure Integrity, Society of Cable Telecommunications Engineers
- S. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings
- T. UL 514B – Conduit, Tubing, and Cable Fittings
- U. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Shop drawings shall show the position of all underground telecommunications Vaults, Pull Boxes, Hand Holes, Ducts, Duct Banks and Conduits.
 - 2. Drawings are to indicate as-built fill percentages on all conduits within the project scope
- C. Submit Manufacturer’s Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer’s cut sheets for approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Refer to Section 27 05 53 for general details.
- B. All Vault Covers, Pull Box and Hand Hole lids are to be factory labeled (at minimum) “COMMUNICATIONS”. (See Fig. #156 & 157 in Appendix B)
- C. All copper and fiber cables run underground shall be labeled in each Vault, Pull Box, Hand Hole, and Pull Box with the appropriate label as detailed in Section 27-05-53, and described in the Labeling, Design and Syntax Standard in Appendix B.

1.06 DEFINITIONS

- A. Duct: Interchangeable term for a conduit.
- B. Duct Bank: An assembly of conduits that may either be directly buried in earth or encased in concrete.
- C. Signal Hand Hole (SHH): Small underground structure (15” x 20” x 10”) containing a maximum of one 2” conduit and is typically used for distribution to a single end point.
- D. Signal Pull Box (SPB): Small underground structure (15” x 26 x 18”) containing a maximum of two 4” conduits.
- E. Signal Manhole (SMH): Large underground structure of varying size used for 4” conduits.
 - 1. Up to six 4” conduits minimum vault size is 5’ x 7’ x 7.’
 - 2. Six to twelve 4” conduits minimum vault size is 6’ x 10’ x 7”.
 - 3. Thirteen to eighteen 4” conduits minimum vault size is 6’ x 12’ x 7.”
 - 4. Nineteen to twenty four 4” conduits minimum vault size is 8’ x 15’ x 7”.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- B. A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise.

2.02 METALLIC CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complies with NEMA TC 3 and UL 514B.

2.03 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-40-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide the minimum duct spacing indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape:
 - a. Tape is to be metal/detectable.
 - b. Color: Orange
 - c. Labeled "FIBER OPTIC CABLE" or "COMMUNICATIONS"
- C. Approved Manufacturers: Lamson & Sessions; Carlon Electrical Products, Manhattan/CDT; a division of Cable Design Technologies, Spiraduct/AFC Cable Systems, Inc. or Cal Poly ITS Telecomm group approved equal.

2.04 PRECAST CONCRETE SIGNAL PULL HOLE (SPH)

- A. Comply with ASTM C 858 for design and manufacturing processes.
- B. Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the hand hole.
- C. Cover Legend: Molded lettering, "COMMUNICATIONS" (at minimum)
- D. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
- E. Approved Manufacturers: Christy Concrete Products, Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co. or Cal Poly ITS Telecomm group approved equal.

2.05 PRECAST CONCRETE SIGNAL PULL BOX (SPB)

- A. Comply with ASTM C 858 for design and manufacturing processes.
- B. Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the pull box.
- C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- D. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- E. Cover Legend: Molded lettering, "COMMUNICATIONS" (at minimum) (See Fig. #156 & 157 in Appendix B)
- F. Configuration: Units shall be designed for flush burial.
- G. Extensions and Slabs: Designed to mate with bottom of enclosure. Use the same material as enclosure.
 - 1. Extension shall provide increased depth of 12 inches.
 - 2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
- H. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of pull boxes, but close enough to corners to facilitate racking of cables on walls.
 - 2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - 3. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- I. Duct Entrances in Pull Box Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1. Type and size shall match fittings to duct or conduit to be terminated.
 - 2. Fittings shall align with elevations of approaching ducts and be located near interior corners of pull boxes to facilitate racking of cable.
 - 3. All ducts entering pull boxes shall be grouted in place flush with the finished surface.
- J. Pull Boxes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- K. Approved Manufacturers: Christy Concrete Products, Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co. or Cal Poly ITS Telecomm group approved equal.

2.06 PRECAST SIGNAL MANHOLE (SMH)

- A. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
- B. Windows: Precast openings in walls, arranged to match dimensions and elevations of

approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment.

1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of vaults, but close enough to corners to facilitate racking of cables on walls.
2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
3. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
4. Duct Entrances in Vault Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of vaults to facilitate racking of cable.
 - c. All ducts entering vaults shall be grouted in place flush with the finished surface.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground- water level at grade.
- E. Approved Manufacturers: Christy Concrete Products, Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co. or Cal Poly ITS Telecomm group approved equal.

2.07 UTILITY STRUCTURE ACCESSORIES

- A. Approved Manufacturers: Bilco Company (The), Campbell Foundry Company, Christy Concrete Products, McKinley Iron Works, Inc., Oldcastle Precast Group, Utility Concrete Products, LLC, Utility Vault Co., or Cal Poly ITS Telecomm group approved equal.
- B. Vault Frames, Covers, and Chimney Components: Comply with structural design loading specified for vault.
 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
 - a. Cover Finish: Nonskid finish shall have a 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.
 - a. Legend: "COMMUNICATIONS" (at minimum), for Telecommunications, data, and telephone duct systems. (See Fig. #156 & 157 in Appendix B)
- C. Vault Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye,

rated 2500- lbf. minimum tension.

- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf 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 ID by 2- 3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000-lbf minimums.
- H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800- lbf rated shear strength.
- I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions. Provide two arms per stanchion section.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- J. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35° F. Capable of withstanding temperature of 300° F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. (See Fig. #136 in Appendix B)
- K. Fixed Vault Ladders: Arranged for attachment to wall of vault. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- L. Cover Hooks: Heavy duty, designed for lifts 60 lbs. and greater. Two required.

2.08 UNDERGROUND ENCLOSURE APPLICATION

- A. SPH & SPB:-
 - 1. Units in Roadways and Other Deliberate Traffic Paths:
 - a. Precast concrete. AASHTO HB 17, H-10 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non- deliberate Loading by Heavy Vehicles:
 - a. Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles:
 - a. Precast concrete, AASHTO HB 17, H-10 structural load rating.
- B. Vaults: Precast or cast-in-place concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles:

- a. AASHTO HB 17, H-20 structural load rating.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles:
 - a. AASHTO HB 17, H-10 structural load rating.

2.09 DUCT SEAL (POPULATED WITH CABLING)

- A. To be used only in situations where a fire rated assembly is not required.
- B. Shall be Asbestos Free, easily formable clay.
- C. Shall not dry hard but shall be re-entenable/reusable.
- D. Shall be Resistant to water, alcohols, solvents & fuels
- E. Shall be non-corrosive to metals or plastics and a non-irritant to skin.
- F. Approved Manufacturer: Gardner Bender DS-130 or Cal Poly ITS Telecomm group approved equal.

2.10 DUCT SEAL (UNPOPULATED CONDUITS)

- A. To be used only in situations where a fire rated assembly is not required.
- B. Shall be removable and reusable compression type fittings. **(See Fig. #137 in Appendix B)**
- C. Shall be corrosion proof, water-tight and gas-tight.
- D. Shall be equipped with a rear side pull rope tiedown.
- E. Approved Manufacturer: Cherne Industries, Inc. (Gripper) or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Cut trenches neatly and uniformly, and slope uniformly away from underground structures and building entrances.
- B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Replace removed sod immediately after backfilling is completed.

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and shall be meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and all relevant codes.

3.03 INSTALLATION

- A. Conduit and Duct Installation
 1. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.
 2. Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain away from building entrances.

3. Use manufactured long sweep bends with a minimum radius of 48" both horizontally and vertically at all locations.
 4. Make joints in ducts and fittings watertight in accordance with manufacturer's instructions. Duct joint sealing should be avoided if ambient temperature is over 86° (F). Stagger couplings so those adjacent ducts do not lie in the same plane.
 5. Space cast-in-place end bells approximately 8 inches on center in a pattern that best meets the requirements of the arrangement of the duct bank for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end bell spacing, 10 ft. from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into vault walls from both sides to provide watertight entrances.
 6. Support concrete encased nonmetallic ducts on plastic separators coordinated with duct size and required duct spacing, and install according to the following:
 - a. Space separators 4-feet on centers to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.
 - b. Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between vaults or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of joint near the corners of the envelope.
 - c. Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise use forms.
 - d. Three inches minimum clearance between ducts and exterior envelope wall, 7.5 inches minimum clearance between ducts for like services and 12 inches minimum clearance between power and signal ducts.
 - e. Except as otherwise indicated on the Civil drawings, install top of duct bank at least 36 inches below finished grade.
 7. Use galvanized rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches of concrete.
 8. Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
 9. Install 600-pound test nylon rope as a pull rope in ducts, including spares.
- B. Duct Installation
1. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
 2. Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie

- in same plane.
3. At duct entrances to vaults, pull boxes and hand holes, use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - b. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to vaults, pull boxes and hand holes.
 - c. Grout end bells into structure walls from both sides to provide watertight entrances.
 4. For building wall penetrations, make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.
 5. Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi hydrostatic pressure.
 6. Concrete-Encased Ducts: Support ducts on duct separators.
 - a. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. 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.
 - b. Pour each run of envelope between vaults or other terminations in one continuous operation. Unless otherwise specified, the term "concrete", as it relates to the fill envelope encasing buried communications duct banks, shall mean a "2 bag" sand slurry mix.
 - (1) Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - (2) If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 36 inches into concrete on both sides of joint near corners of envelope.
 - c. Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - d. Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - e. 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.

- f. Provide 3 inches minimum space between ducts and exterior envelope wall, 2 inches minimum space between ducts for like services, and 4 inches minimum space between power and signal ducts.
 - g. Install top of duct bank at least 36 inches below finished grade in areas not subject to deliberate traffic, and also at least 36 inches below finished grade in deliberate traffic paths for vehicles, unless greater depth is otherwise indicated on approved drawings.
 - h. Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - (1) Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - (2) Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - i. Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
7. Direct-Buried Duct Banks:
- a. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - b. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 - c. Install ducts with a minimum of 3 inches between ducts for like services and 12 inches between power and signal ducts.
 - d. Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated on approved drawings.
 - e. Set elevation of bottom of duct bank below the frost line.
 - f. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - (1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - (2) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
8. Duct Entrances to Buildings:
- a. For entrances using steel or schedule 80 PVC conduit, transformations from underground duct to conduit shall be made 10 ft. minimum, outside the building wall and shall use fittings manufactured for the purpose. Install in accordance with the following:

- b. For entrances using Concrete-Encased Ducts, install reinforcing in duct banks through disturbed earth near buildings and excavations and coordinate duct bank with structural design at wall so duct bank is supported at wall without reducing structural or watertight integrity.
 - c. For waterproof entrances: Where ducts enter buildings through a waterproofed floor or wall, a watertight entrance-sealing device shall be installed with the sealing gland assembly on the inside. The device shall be securely anchored into the masonry construction with one or more integral flanges and the membrane waterproofing secured to the device in a permanently watertight manner.
- C. Underground Utility Structure Installation
1. Install vaults with roof top 24 inches below finished grade, typical. Covers shall be adjusted to finish grade and carefully grouted in to provide adequate bearing for H-20 traffic loading.
 2. Install removable hardware including cable stanchions, cable arms, and insulators as required for installation and support of cable and conductors. (See Fig. #165 in Appendix B)
 3. Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field.
 4. Install precast concrete underground structures as indicated, according to manufacturer's written instructions and ASTM C 891.
 - a. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.
 - b. Support units on a 12-inch level bed of crushed stone or gravel, graded from the 1-inch sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- D. Installation of Concrete Vaults, Pull Boxes, and Hand Holes
1. Precast Concrete Vault and Pull Box:
 - a. Comply with ASTM C 891, unless otherwise indicated.
 - b. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - c. Unless otherwise indicated, support units shall be placed on a 12" deep level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
 2. Elevations:
 - a. Vault Roof: Install with rooftop at least 15 inches below finished grade.
 - b. Vault Frame: In paved areas and traffic-ways, set frames flush with finished grade.
 - c. Pull Box Covers: In paved areas and traffic-ways, set surface flush with finished grade.
 - d. Where indicated, cast pull box cover frame integrally with pull box structure.
 3. Install drains in bottom of vaults where indicated. Coordinate with drainage provisions indicated.
 4. Circular opening in Vault roof; sized to match cover size.
 - a. Vaults with Fixed Ladders: Offset access opening from vault centerlines to align with ladder.

- b. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with vault roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
 - c. No more than a total of 24" of traffic rings are to be used.
5. Apply waterproofing to exterior surfaces of vaults and pull boxes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of vault chimneys after mortar has cured at least three days.
 6. 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.
 7. Install fixed vault ladders to provide for safe entry with maximum clearance from cables and other items in vaults.
- E. CLEANING
1. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch greater than internal diameter of duct.
 2. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
 3. Clean internal surfaces of vaults, including sump. Remove foreign material.

3.04 GROUNDING & BONDING

- A. Install ground rod through floor of each vault with top protruding 4 inches above floor. Ground rod shall be installed during placement of the vault, in a corner of the vault. Ground rod is not to be placed in the center of the vault.
- B. Seal the floor opening against water penetration with waterproof non-shrink grout.
- C. Ground all exposed metal components and hardware with #2 bare copper ground conductor. Train conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors.
- D. A continuous #2 bare copper conductor shall extend with each conduit or duct bank entering and leaving the structure to the next underground structure or building. This conductor shall be bonded to the duct bank steel reinforcement bar (if used) every 20'.
- E. All ground connections for underground structures shall be installed using exothermic welding. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000, ISO 10012 and traceable to NIST standards.

- B. Testing: demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.
 - 1. Test vault grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
 - 2. Rod ducts with a mandrel 1/4 inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.
 - 3. Test for water leaks.
- C. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.
- D. All testing must be done in the presence of a Cal Poly ITS Telecomm group representative.

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the position and depth of all underground telecommunications vaults, pull boxes, hand holes, ducts, duct banks and conduits.
- B. Drawings are also to indicate as-built fill percentages on all conduits within the project scope.

END OF SECTION 27 05 43

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SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
1. Labeling systems and accessories.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm, Telecommunications Standards Document and the Labeling, Design & Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
1. Submit "nomenclature" plan/drawings for acceptance by the Cal Poly ITS Telecomm group prior to labeling the insides of outdoor pull boxes, pull holes, vaults/manholes and EF/ER/TR backboards.
 2. Prepare nomenclature for the purpose of providing conduit destination information in every pull box, pull hole and vault/manhole that is to be stenciled on the wall above each conduit penetration. Encircle on the wall in black ink groups of conduits going to the same destination.
 3. In areas where stenciling is not possible, epoxy a Cal Poly ITS Telecomm group approved engraved "sign" with the appropriate nomenclature above the conduit penetrations.
- C. Submit Manufacturer's Cut Sheets for the following:
1. Manufacturers' cut sheets for all labeling PRODUCTS shall be submitted to and approved by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. All elements (facilities, underground elements, conduits, cables, ground wires, racks, faceplates, jacks, circuits, boxes, etc.) of the telecommunications system are to be labeled.
- B. See PRODUCTS section for specific details.
- C. NOTE: The cable identification or name of fiber optic cables does not describe the cable, it only identifies or names the cable. To determine specific strand counts and cable types for each project contact the Cal Poly ITS Telecomm group. After all the required cable testing is performed and the results have been reviewed and approved, the Cal Poly ITS Telecomm group shall install patch cables and connect all equipment and nodes to the active fiber network.

1.06 DEFINITIONS

- A. Room Number – If the location is an EF/ER/TR, the room number will be provided by others. Typically, Facilities Services, Planning and Capital Projects in concert with the Project Architect will establish a room numbering plan for the project. In remodel situations, if the location is an end user space, use its room number.
- B. Underground Facility – Manholes, Hand Holes, Pull Holes, and Entrance Vaults.
- C. For more detailed information see the Cal Poly ITS Telecomm group Labeling, Design & Syntax Standards in Appendix B.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.
- B. For proper labeling information and criteria, see the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

2.02 CABLE LABELS

- A. All labels shall be machine generated. Hand written labels are not acceptable. (See Fig. #102 in Appendix B)

B. Labels shall be made of durable material typically used to create permanent labels (1" white nylon with black lettering).

C. Acceptable Manufacturers: DYMO, 3M or Cal Poly ITS Telecomm group approved equal.

2.03 LABELS FOR STATION CABLES

A. 1" white nylon with black lettering.

B. Acceptable Manufacturers: DYMO, 3M or Cal Poly ITS Telecomm group approved equal.

2.04 FACEPLATE LABELS FOR OUTLETS

A. See the Cal Poly ITS Telecomm Labeling, Design & Syntax Standards in Appendix B.

B. Acceptable Manufacturers: DYMO, 3M

2.05 LABELS FOR INDOOR RACKS, CABINETS AND PANELS

A. ½ "white polyester or nylon with black lettering (See Fig. #103 – 107 in Appendix B)

B. See the Cal Poly ITS Telecomm Labeling, Design & Syntax Standards in Appendix B.

C. Acceptable Manufacturers: DYMO, 3M or Cal Poly ITS Telecomm group approved equal.

2.06 LABEL PLATE FOR OUTDOOR CABINETS

A. Anodized aluminum name plate engraved with "COMMUNICATIONS".

B. See the Cal Poly ITS Telecomm Labeling, Design & Syntax Standards in Appendix B.

C. Provide Submittal for acceptance by the Cal Poly ITS Telecomm group.

PART 3 – EXECUTION

3.01 GENERAL

A. Conduits

1. Intrabuilding Conduits (1" white label with black lettering)

a. Line 1: Room Number and TR ID for each end of the conduit.

b. Line 2: Number of this conduit related to conduits with the same two endpoints.

c. Label both ends of a conduit with identical tags.

d. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

2. Interbuilding Conduits (1" white labels with black lettering)

a. Line 1: Label with designation for the far end, Building Number and Room Number, or appropriate designation for an Underground Facility.

b. Line 2: Number of this conduit related to conduits with the same endpoints.

Underground conduits shall be labeled as on the butterfly drawings.

- c. Label both ends of a conduit with identical tags.
- d. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

B. Copper Cables

1. Intrabuilding Backbone Copper Cables (1" white labels with black lettering)
 - a. Line 1: Room Number or TR ID for each end of the cable (example: "B180-105/B180-114-1).
 - b. Line 2: Number of pairs in relation to the total between the same two endpoints
Example: "PRS 1-100" or "PRS 301-400")
 - c. Label both ends of a cable with identical labels.
 - d. See the Cal Poly ITS Telecomm Labeling Design & Syntax Standards in Appendix B.
2. Interbuilding Backbone Copper Cables (1" white labels with black lettering)
 - a. Line 1: Building and Room Number for each end of the cable. (Example: "B180-106/B180-532")
 - b. Line 2: Number of pairs in relation to the total between the same two endpoints.
 - c. Label both ends of a cable with identical labels.
 - d. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
3. Copper Station Cable / Faceplate ID
 - a. Faceplate upper label designation:
 - (1) First number is the room the faceplate is serving.
 - (2) Second number is the designation for any specific faceplate in a room.
 - (3) Faceplate port label designation: (for the campus standard 4 port faceplate)
(See Fig. #108 & 109 in Appendix B)
 - Upper left port: "W"
 - Upper right port: "X"
 - Lower left port: "Y"
 - Lower right port: "Z"
 - b. Faceplate lower label designation:
 - (1) First word is "To:" (See Fig. #108 in appendix B)
 - (2) Following number is the Room Number of the ER/TR serving that faceplate.
 - c. Examples:
 - (1) Upper label: 241-A-3 (Apartment #, Bedroom #, Faceplate #) (See Fig. #108 in Appendix B)
 - (2) 4 Port designations: W X
 Y Z
 - (3) Lower label: To: 205 (Telecomm Room Number serving this faceplate)
 - d. Label both ends of a cable with identical tags.
 - e. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
4. Copper Station Cables (1" white labels with black lettering)
 - a. Line 1: Cable designation: Room Number - Faceplate Number & Port designation

Example: "241-3W" or "241-3X" or "241-3Y" or "241-3Z" (See Fig. #107 in AppendixB)

- b. Label both ends of a cable with identical labels.
- c. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

C. Fiber Optic Cables

1. Intrabuilding Fiber Optic Backbone Cables (1" white labels with black lettering)
 - a. Multimode Fiber: FMB002-004/B002-192-1 (Fiber Multimode, from Building 002 - Room 004 / to Building 002 - Room 192 -Cable Number 1)
 - b. Single Mode Fiber: FSB002-004/B002-192-1 (Fiber - Single Mode, from Building 002 - Room 004 / to Building 002 - Room 192 - cable 1)
 - c. Label both ends of a conduit with identical labels.
 - d. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
2. Interbuilding Fiber Optic Backbone Cables (1" white labels with black lettering)
 - a. Multimode Fiber: FMB013-105/B011-101-1 (Fiber Multimode, from Building 013 -Room 105 / to Building 011 - Room 101, cable 1)
 - b. Single Mode Fiber: FSB013-105/B011-101-1 (Fiber - Single Mode, from Building 013 -Room 105 / to building 011 - Room101, cable 1)
 - c. Label both ends of a cable with identical labels.
 - d. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

D. Grounding & Bonding

1. Interbuilding Grounding/Bonding Conductors (1" white labels with black lettering)
 - a. First part of line 1: Ground Type (See Definitions).
 - b. Second part of line 1: Room Number or TR ID for each end of the conductor.
 - c. Label both ends of a conductor with identical labels.
 - d. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
2. Interbuilding Grounding/Bonding Conductors (1" white labels with black lettering)
 - a. First part of line 1: Ground Type (See Definitions).
 - b. Second part of line 1: Building Number (the lower of the two endpoint Building Numbers).
 - c. Third part of line 1: Building Number (the higher of the two endpoint Building Numbers).
 - d. Label both ends of a conductor with identical labels.
 - e. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

E. Wall-field

1. All Wall-field labeling shall be created using machine generated stencils that have been approved in advance by the Cal Poly ITS Telecomm group representative. The labels shall be painted on the backboard in the correct locations and shall be black in color. (See Fig. #101 in Appendix B)

2. For examples see the Cal Poly ITS Labeling, Design & Syntax Standards in Appendix B.
- F. Patch Panels
1. Label panel with correct panel ID number. (See Fig. #104 & 105 in Appendix B)
 2. Label each jack with appropriate cable ID number.
 3. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
- G. Racks
1. Label front of each rack (or ladder rack above) with designated Rack Number within that TR/ER. Rack Numbers start against the wall with Rack number1 and increments as racks are added. (Using ½ inch polyester, machine generated label with black ink) (See Fig. #105 in Appendix B)
 2. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
- H. Cabinets
1. Label with “COMMUNICATIONS” (using ½ inch polyester, machine generated label with black ink)
 2. See the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and shall be meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Installation of all identification type products shall be as detailed in this section, as shown in the Cal Poly ITS Telecomm group Labeling, Design and Syntax Standards in Appendix B, and as per the manufacturer’s printed information. All engraved labels shall be attached mechanically (adhesives may be used in addition) using hardware appropriate for maintaining long-term attachment.

3.04 GROUNDING & BONDING

- A. N/A

3.05 TESTING

- A. N/A

3.06 ACCEPTANCE

- A. Once the installation has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm

group representative will notify the Contractor and/or the Cal Poly Project Manager in writing or by email.

3.07 RECORD (AS-BUILT) DRAWINGS

A. None Required

END OF SECTION 27 05 53

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SECTION 27 08 13 - TESTING OF COPPER CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Cable testing for copper cables.
 - 2. Providing testing results in accordance with the strictest manufacturers' written recommendations.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. None Required
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.
- D. List of test equipment to be used.
- E. Sample of test data to be provided to the Cal Poly ITS Telecomm group representative prior to the start of testing for review, comment and acceptance.
- F. Identity and qualifications of Contractor's personnel who will perform the testing.
- G. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.

1.05 IDENTIFICATION

- A. For details, refer to Section 27 05 53 and the Cal Poly ITS Telecomm group Labeling, Design and Syntax Standards in Appendix B.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 CATEGORY 3 UTP CABLE TESTER

- A. Testing for all cables 25 pair or larger are to use a tester that tests 25 pair at a time.
- B. The field tester must meet the requirements of ANSI/TIA/EIA-568.
- C. Make and model to be submitted for approval by the Cal Poly ITS Telecomm group prior to start of testing.

2.02 CATEGORY 6 UTP CABLE TESTER

- A. The field tester must meet the requirements of ANSI/TIA/EIA-568-B.2, Addendum 1
- B. Tester must output test results with Fluke's LinkWare reporting software. PDF format is unacceptable. Alternate reporting software may be used if the associated software (with license if required) is given to the Cal Poly ITS Telecomm group. (Software not to be returned)
- C. Make and model to be submitted for approval by the Cal Poly ITS Telecomm group prior to start of testing.

2.03 MULTIMETER

- A. Make and model at Contractor's discretion with Cal Poly ITS Telecomm group approval.

2.04 CATV COAX TESTER

- A. Test equipment for the CATV coax wiring must provide TDR and sweep test information.

PART 3 – EXECUTION

3.01 GENERAL

- A. The Contractor shall test, as described below, all metallic cables installed under these specifications.
- B. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
- C. Where post-manufacturer test data has been provided by the manufacturer on the reel or shipping carton: Submit 2 copies to the Cal Poly ITS Telecomm group representative prior to installing cables.
- D. **Test fully completed systems only. Piecemeal testing is not acceptable.**
- E. **Testing shall not be performed until after all termination hardware is installed and attached, and all labeling and identification has been completed. If all work is not completed prior to testing, test data will be considered not acceptable and shall be redone and resubmitted.**
- F. **Any cable that does not pass all required testing shall be removed, replaced, and retested.**
- G. Remove and replace any defective cables from pathways system. Do not abandon cables in place.

- H. For 100 pair or smaller replace entire cable if a pair or conductor fails a required test. For larger pair count cables, replace if more than 2% of pairs fail a required test.
- I. The Cal Poly ITS Telecomm group reserves the right to observe all portions of the testing process.
- J. The Cal Poly ITS Telecomm group representative further reserves the right to conduct "Proof of performance testing," using Contractor equipment and labor. This shall be a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results. If multiple errors are found, test percentages shall rise.
- K. Perform all tests as required by the manufacturer in support of the structured cabling system warranty.

3.02 QUANTITIES

- A. N/A

3.03 INSTALLATION

- A. N/A

3.04 GROUNDING & BONDING

- A. *All grounding and bonding is to be complete before any system testing is to be attempted.***

3.05 TESTING

- A. All test results are to be defined as acceptable / unacceptable using the requirements of ANSI/TIA/EIA- 568 B.
- B. Copper Cables – General Requirements
 - 1. After terminating and splicing all cables, test all cable pairs for:
 - a. Continuity to the remote end.
 - b. Shorts between any 2 or more conductors or ground
 - c. Transposed pairs
 - d. Reversed Pairs
 - e. Split Pairs
 - f. Crossed Pairs
 - g. Wire map.
 - h. Length.
 - i. Shield Continuity (If shielded)
 - j. Continuity to Grounding (If shielded)
 - 2. Using a (low ohm) multimeter, test continuity to ground (TGB or TMGB) for a maximum resistance of 1Ω, see section 27-05-26 for additional detail.
- C. Indoor Riser or OSP Copper Cable
 - 1. After terminating and splicing the cables. Test all cable pairs for:

- a. DC Loop Resistance for any 2 conductors in the cable
- D. Category 6 Copper Station Cables:
 - 1. After terminating both ends of all 4-pair cables, but before any equipment is installed, test these cables for the following:
 - a. Return Loss
 - b. Insertion Loss
 - c. Attenuation
 - d. NEXT (near-end crosstalk)
 - e. PSNEXT (power sum near-end crosstalk)
 - f. FEXT (far end crosstalk)
 - g. ACR-F (attenuation to crosstalk ratio)
 - h. PSACR-F (power sum attenuation to crosstalk ratio)
 - i. Propagation delay
 - j. Delay skew
 - k. Cable length

3.06 ACCEPTANCE

- A. All test results for CAT 3 cable are to be documented and submitted in the Manufacturer's native format to the Cal Poly ITS Telecomm group representative (both in a binder and electronically) within five (5) working days of test completion. Alternate reporting software may be used if the associated software (with license if required) is given to the Cal Poly ITS Telecomm group. (Software not to be returned)
- B. All test results for CAT 6 cable to be documented and submitted in Fluke LinkWare format to the Cal Poly ITS Telecomm group representative electronically within five (5) working days of test completion. Alternate reporting software may be used if the associated software (with license if required) is given to the Cal Poly ITS Telecomm group. (Software not to be returned)
- C. ***Test result shall be recorded per cable and three identical copies placed on removable media (CD) for delivery to the Cal Poly ITS Telecomm group representative for review and acceptance.*** If test results are found acceptable, the Cal Poly ITS Telecomm group shall inform the Cal Poly Project Manager in writing or by email.
- D. Each test report shall contain the following general information:
 - 1. Date of Preparation.
 - 2. Date of Test.
 - 3. Project Name (Cal Poly building number).
 - 4. Contractor's Name
 - 5. Media Type.
 - 6. Make, Model and Serial Number of test equipment used.
 - 7. Date of Last Calibration.

8. Names of Test Crew.
- E. In addition to the results of the specific tests specified, reports shall also include:
1. Cable ID Number (See the Cal Poly Labeling, Design and Syntax Standards in Appendix B).
 2. Cable Type.
 3. Pair or Conductor Count.
 4. Individual Pair or Conductor Numbers.
 5. Results of Each Test for Each Pair or Conductor.
 6. Total Number of Serviceable Pairs or Conductors in Cable.
 7. Ground Resistance Measurements.
- F. Once the testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. None Required

END OF SECTION 27 08 13

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SECTION 27 08 23 - TESTING OF FIBER OPTIC CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Cable testing for fiber optic cables.
 - 2. Providing testing results in accordance with the strictest manufacturer's written recommendations.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. None Required
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.
- D. Submit a list of test equipment to be used along with most recent calibration information.
- E. Prior to starting, a sample of test data shall be provided to the Cal Poly ITS Telecomm group representative that is indicative of the reports that shall be submitted upon completion of project testing for approval.
- F. Provide the identity and qualifications of Contractor's personnel who will perform the testing. Submit documentation for all test personnel verifying qualified operator training on the proposed test equipment.
- G. Submit a proposed schedule for performing testing at least 2 weeks prior to the start of each test.

1.05 IDENTIFICATION

- A. Refer to Section 27 05 53 for general details.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

- A. The personnel performing field testing shall provide results that meet the requirements of tests specified in ANSI/TIA/EIA-455, inclusive of all subsections.
- B. Make and model of test equipment requires approval of the Cal Poly ITS Telecomm group. The Cal Poly ITS Telecomm group currently has licensed copies of Agilent Technologies Traceviewer III and Fluke Linkware. If other manufacturer's test equipment is used the contractor shall deliver to the ITS Telecomm group a licensed copy of the necessary software to read and manipulate the test data as part of the contract. The software shall remain the property of the ITS Telecomm group.
- C. Included in the test results submitted shall also be OTDR traces and power loss sum information for each fiber optic core.

2.02 OPTICAL POWER MEASUREMENT EQUIPMENT

- A. Fluke Networks Linkware
 - 1. SimpliFiber
 - 2. OMNIScanner w/ Fiber Test Adapters or Cal Poly ITS Telecomm group approved equal.

2.03 OPTICAL FIBER INSPECTION SCOPE

- A. Fluke Networks
 - 1. Fiber Inspector Pro
- B. Other Inspection Scopes, if used, shall be Approved in advance by the Cal Poly ITS Telecomm group.

PART 3 – EXECUTION

3.01 GENERAL

- A. The Contractor shall test, as described below, all fiber optic cables installed under these specifications.
- B. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
- C. Where post-manufacturer test data has been provided by the manufacturer on the reel or shipping carton: submit copies to the Cal Poly ITS Telecomm group representative prior to

installing cables.

- D. Test fully completed systems only. Piecemeal testing is not acceptable.
- E. Testing shall not be performed until after all hardware is installed and attached, and all labeling and identification has been completed. Using any other methodology shall render the test data not acceptable.
- F. Any cable that does not pass all required testing shall be removed or replaced and retested.
- G. Remove and replace any defective cables from pathways system. Do not abandon cables in place.
- H. The Cal Poly ITS Telecomm group representative reserves the right to observe all portions of the testing process.
- I. The Cal Poly ITS Telecomm group further reserves the right to conduct "Proof of performance testing", using Contractor equipment and labor, by random re-testing of up to ten percent (10%) of the cable plant, to confirm documented test results. Multiple failures shall cause the percentage of the cable plant to be tested to increase.
- J. Perform all tests as required by the manufacturer in support of the structured cabling system warranty.

3.02 QUANTITIES

- A. N/A

3.03 INSTALLATION

- A. N/A

3.04 GROUNDING & BONDING

- A. N/A

3.05 TESTING

- A. All test results shall be defined as acceptable / unacceptable by the requirements of ANSI/TIA/EIA- 526, inclusive of all subsections.
- B. Fiber Optic Cables – General Requirements
 - 1. Index matching fluids or gels shall not be used.
 - 2. Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. Faults related to affixing the connector shall be corrected, and the fiber re-tested as described above, until acceptable attenuation measurements are recorded. If acceptable attenuation cannot be achieved, than the fiber shall be replaced in its entirety.
- C. Optical Time Domain Reflectometer Testing
 - 1. All OTDR testing procedures and field test instruments shall comply with applicable requirements of: EIA/TIA 455-78 and EIA/TIA 455-133.
 - 2. OTDR test jumpers must meet the criteria for reference jumpers specified in EIA/TIA-455-171.
 - 3. A 1,000 foot launch cable shall be installed between the OTDR and the first link connection.
 - 4. A 1,000 foot receive cable shall be installed after the last link connection.

5. All cables shall be OTDR tested at 1310 nm and 1550 nm for Single-mode operating wavelength anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 6. All cables shall be OTDR tested at 850 nm and 1300 nm for Multi-mode operating wavelength anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 7. All fiber links shall be tested in both directions.
 8. Optical Return Loss (ORL) for each link shall be measured and documented.
 9. Fiber Length shall be measured and documented.
 10. Perform a high resolution OTDR test with tracing printouts noting each optical fiber and buffer tube color designation.
- D. Optical Power Loss Testing
1. All fiber optic cables are to be tested via the One-Jumper Reference Method, formerly Method B.
 2. Perform end-to-end, bi-directional attenuation (loss) test for each fiber strand at 850nm and 1300nm for multi-mode fiber or at 1310nm and 1550nm for single mode fiber.
- E. Other Tests
1. After installation of connectors, visually inspect each fiber end-face at 200x magnification for multi-mode fiber and 400x magnification for single mode fiber. Replace fibers with visible defects and/or striations in the core area.

3.06 ACCEPTANCE

- A. All test results and corrective procedures shall be documented and submitted, in the manufacturer's approved software format, to the Cal Poly ITS Telecomm group representative (with software and license if necessary) within five (5) working days of test completion. Test results submitted in the PDF format shall not be acceptable.
- B. Each test report shall contain the following general information:
1. Date of Preparation
 2. Date of Test
 3. Project Name (shall be: Start Building # / End Building #, with the same name used at both ends)
 4. Contractor's Name
 5. Media Type (MM / SM)
 6. Make, Model and Serial Number of test equipment used
 7. Date of Last Calibration
 8. Names of Test Crew.
- C. Submit the following information regarding the optical fiber cable testing:
1. Cable Number (use Cal Poly Labeling, Design & Syntax Standard methodology in Appendix B)
 2. Fiber Count
 3. Individual Fiber Numbers
 4. Connector Types
 5. Number of Connectors / Patches
 6. Calculated Maximum Link Loss

7. Length of Run
 8. Results of Each Test for Each Fiber
 9. Measured Link Loss for Each Fiber.
- D. Test result shall be recorded per cable and identical copies placed on three removable media devices (CD or DVD) for delivery to the Cal Poly ITS Telecomm group representative (along with software and license if necessary). The PDF format shall be unacceptable. (Software will not be returned)
- E. Once the testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. None Required

END OF SECTION 27 08 23

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SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Basic telecommunications room (TR/ER) requirements in accordance with relevant codes and best industry practices.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. None Required
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets for approval by the Cal Polly ITS Telecomm group.

1.05 IDENTIFICATION

- A. All electrical outlets/faceplates are to be labeled as to Panel and Circuit ID.
- B. Refer to Section 27 05 53 for general details.
- C. Refer to the Cal Poly Labeling, Design & Syntax Standard in Appendix B

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

1.08 TELECOMMUNICATIONS ROOM REQUIREMENTS

- A. Location
 - 1. The length of horizontal cable from each (ER/TR) shall be a maximum of 290 cable feet.

2. The ideal placement of an ER/TR shall be such that all served outlet locations are within 150' of the room.
 3. ERs/TRs shall be located as close as is practical to the center of the area being served.
 4. ERs/TRs must be accessible from a public hallway or other common area.
 5. ***In multi-floor buildings, each floor is to be served by a dedicated ER/TR located on that floor. The EF/ERs/TRs shall be stacked vertically in a 2 hour, fire rated shaft.***
 6. TRs shall be located so they are not restricted by building components that limit expansion or access (e.g., elevators, core, outside walls, fixed building walls, mechanical and electrical equipment rooms).
 7. ***EF/ERs/TRs shall be located so as not to be a flood threat. For example, locations that are below or adjacent to areas of potential water hazard (e.g., restrooms, kitchens, etc.) shall be avoided. Additionally, areas having floor drains shall be avoided.***
 8. ERs/TRs shall be located away from sources of electromagnetic interference (e.g., electrical power supply transformers, motors, generators, X-Ray/MRI equipment and radio or radar transmitters).
 9. ***EF/TRs/ERs shall be located and constructed such that manholes and other external "pull points/boxes" cannot channel water into the building regardless of the water level within.***
- B. Location (Building Entrance Facility (EF) Specific)
1. ***The EF should be nearest the point of entry for conduits entering from the underground.*** (See Fig. #136 & 137 in Appendix B)
 2. Where possible the entrance cabling should be terminated on a bearing wall to reduce the possibility of relocating the termination space if the building is expanded or altered in the future.
- C. Doors & Access
1. ***ERs/TRs/EFs shall be located in a publicly accessible area (e.g., hallway) and their doors shall open outwards.***
 2. ERs/TRs/EFs shall have keyed locks that open with the University Telecomm standard key or master for EFs/TRs/ERs/.
 3. The door to the ERs/TRs/EFs shall be a minimum of 3 feet wide, opening fully (180 degrees on flat wall, 90 degrees in the corner).
 4. When opening into an area containing outside contaminants, the door shall be sealed and provided with a door sweep.
- D. Size
1. ER/TR rooms shall be a minimum of 10' x 12'. ***(See Fig. #148 in Appendix B)***
 2. ERs/TRs/EFs planned to serve more than 200 network connections shall be a minimum of 10' x 15'.
 3. In ERs/TRs planned also to act as an EF, add 3' to the length of the room.
 4. ***When establishing the size of EFs/TRs/ERs, consideration shall be given to the size of the building, the floor space served, the occupant needs, the services deployed and future growth.***
- E. Walls & Backboard
1. Each telecommunications space will have all walls covered from one foot above finished floor to 9' with ¾ inch x 4-foot x 8-foot fire-rated plywood panels securely fastened to the wall framing

members. The screw heads must be flush with the plywood face. The plywood is to be sanded smooth (not rough), void-free and painted with two coats of white paint on out-facing side with the exception of the stamped area on the plywood indicating that it is fire-retardant which shall remain visible at all times. **(See Fig. #146 in Appendix B)**

2. EF/TR/ER walls shall extend from floor slab to ceiling deck with no drop ceilings. The minimum walls height shall be 9'-0".
3. Cables that are to be terminated on a backboard shall be routed on the ladder racking around the perimeter to a point directly above the termination hardware.
4. Conduit must not be routed across the backboards. It shall be enclosed within the wall.

F. Floors

1. **Communications room floors shall be sealed and tiled with anti-static tile.**
2. ERs/TRs shall be located on floor areas designed with a minimum floor loading of 50 lbs/ft²).

G. Ceiling

1. The minimum ceiling height is 9 feet above the finished floor.
2. For EFs/TRs/ERs with a ceiling distribution system, the ceiling should be open (No false/suspended ceilings) so that there is easy access to the conduit, raceways, cables, etc. entering the room.

H. Conduit

1. **Conduits that protrude through the floor of EFs/TRs/ERs shall extend 3-inches (minimum) above the finished floor.**
2. **Conduits entering the EFs/TRs/ERs through the floor shall enter no further than 3" from a wall.**
3. One 4" trade size conduit (minimum) is required (specifically for riser cable) per 50,000 sq. ft. of usable floor space served by that backbone/riser system, plus two spares for a minimum of three conduits per EF/TR/ER.
4. One conduit serving each EF/TR/ER shall have four (4) - 1 ¼" HDPE innerduct runs installed within for fiber optic cable. The innerduct shall be plenum rated when inside the building envelope. All innerduct installations shall house a preinstalled pull tape. See Section 27-05-33 for more details.
5. Install mule tape or pull cord in all conduits regardless of percentage fill. **(See Fig. #138 in Appendix B)**

I. Environmental Service

1. HVAC shall be provided by use of a ducted system, when components are placed outside the ER/TR.
2. **HVAC shall be included in all ERs/TRs to maintain equipment reliability and longevity and to reduce the number of man-hours of maintenance required annually. The HVAC system shall be continuous (24 hours per day and 365 days per year).**
3. Temperature: 60-degrees to 85-degrees Fahrenheit
4. Humidity (non-condensing): 30-percent to 60-percent
5. A positive air pressure shall be maintained with a minimum of four air changes per hour.
6. The ER/TR shall be protected from contaminants and pollutants that could affect electronic equipment.

J. Fire Detection /Protection

1. **All EFs/TRs/ERs shall be provided with a portable CO2 fire extinguisher with current certification.**
2. All EFs/TRs/ERs shall be provided with a smoke or heat detector tied into the building's fire alarm system.
3. **Unless required by the AHJ, water charged fire sprinklers shall not to be placed in EFs/TRs/ERs.**

K. Firestop & Duct Sealing

1. Any conduits that enter an ER/TR/EF from the exterior of the building shall be sealed at both ends (to prevent vapor from entering) with a product specifically UL listed for that application. **(See Fig. #136 & 137 in Appendix B)**
2. Also refer to Section 27-05-43 for additional detail.
3. All firewall penetrations into EFs/TRs/ERs shall be sleeved and Firestop applied. All Firestopping shall match the specific fire rating of the wall. Products used shall be reusable/re-enterable to allow for additional cabling and maintenance.
4. Also refer to Section 27-05-37 for additional detail.

L. Lighting

1. Install T-8 fluorescent lighting a minimum equivalent of 500 lux (50 foot-candles) measured 1 m (3-feet) above the finished floor at the front and rear of the rack equipment to be installed.
2. Light switches shall be located for easy access upon entry, and shall not to be motion sensitive.
3. Light fixtures shall be mounted 9' feet above the finished floor and caged or use sheathed lamps for shatter protection.
4. At least one fixture shall be on emergency or battery power.
5. Light ballast shall not be within 1' of telecommunications cable, and the light fixture itself shall not be within 5". This is typically an issue around the telecom ladder racking and cable trays used to route telecom cable.
6. A typical EF/TR/ER shall include at least two 8' light rows placed parallel to the racks to illuminate the backboards and equipment. (4 - 4' light fixtures in 2 rows may be used) **(See Fig. #148 in Appendix B)**

M. Electrical

1. Communications Equipment circuits in initially unpopulated rooms:
 - a. TRs/ERs shall provide a minimum of four (4) dedicated, protected, non-switched 3-wire 120-volt, 20 amp, NEMA 20R duplex electrical outlets, **in locations approved by the Cal Poly ITS Telecomm group**, each on separate branch circuits. Each outlet is to be placed in its own back box. **Label all outlet faceplates and power panel breaker locations.** (See section 25- 05-53 for more detail)
 - b. In each ER/TR provide a single dedicated, protected, non-switched 4-wire 125/250 VAC, 30 amp, NEMA L14-30R electrical outlet, **in a location approved by the Cal Poly ITS Telecomm group. Label all outlet faceplates and power panel breaker locations.** (See section 25-05-53 for more detail)
2. Convenience outlets (tools, test sets, etc.)
 - a. Provide 1 separately protected 3-wire, 120-volt, 20 amp, non-switched circuit, wired to one duplex, NEMA 20R, outlet on each wall. Mount the outlets, inset in the plywood backboards,

at normal outlet height, and placed no more than 12' apart, around perimeter walls. Convenience outlets shall also be identified and labeled. **(See Fig. #148 in Appendix B)**

3. Conduit for electrical circuits shall not be run on top of plywood backboards. Route all conduits around or behind the backboard (inside the wall).
4. Distribution Panels
 - a. TRs/ERs shall contain their own electrical panel for circuits specific to the outlets and equipment within that room. **(See Fig. #149 in Appendix B)**
 - b. Distribution panels that serve TRs/ERs shall be dedicated for that purpose only.
 - c. The electrical panel serving EFs/TRs/ERs shall be grounded to that facility's TMGB or TGB.
- N. Shared Use
 1. Shared use of any EF/TR/ER with other building facilities shall not be allowed.
 2. Telecommunications spaces shall be dedicated to the telecommunications function and their related support facilities and shall not contain unrelated equipment.
 3. ***EFs/TRs/ERs shall not be shared with building or custodial services, security systems, fire alarm systems, card access systems, servers, non-telecom electrical panels, or other building systems.***

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted.

2.02 PLYWOOD BACKBOARD

- A. Shall be 4' x 8' x 3/4" A/C, fire rated plywood with appropriate stamp affixed. The stamp is to remain visible at all times. **(See Fig. #146 in Appendix B)**
- B. Shall be painted with white (light colored), acrylic, interior, fire-retardant paint on all sides and edges.

2.03 DUCT SEAL (CONDUITS POPULATED WITH CABLING)

- A. Shall be used only where a fire rated assembly is not required.
- B. Shall be of Asbestos Free, easily formable clay. **(See Fig. #136 in Appendix B)**
- C. Shall not dry hard and shall be re-enterable/reusable.
- D. Shall be Resistant to water, alcohols, solvents & fuels
- E. Shall be non-corrosive to metals or plastics and a non-irritant to skin.
- F. Approved Manufacturer: Gardner Bender or approved Cal Poly ITS Telecomm group equal

2.04 DUCT SEAL (UNPOPULATED CONDUITS)

- A. Shall be used only where a fire rated assembly is not required.
- B. Shall be removable and reusable compression type fitting/plug.
- C. Shall be corrosion proof, water-tight and gas-tight.
- D. Shall be equipped with a rear side pull rope tied down

- E. Approver Manufacturer: Osburn Associates Inc, Cherne Industries, Inc. or approved Cal Poly ITS Telecomm group equal. **(See Fig. #137 in Appendix B)**

PART 3 – EXECUTION

3.01 GENERAL

- A. Refer, as appropriate, to other Division 27 specifications for specific execution instructions.

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- B. A. Follow manufacturer's complete instructions for installation and configuration of all products used.

3.04 GROUNDING & BONDING

- A. All EFs/TRs/ERs shall be provided with a telecommunication grounding busbar (TGB). **(See Fig. #140 & 164)**
- B. All equipment, racks, metal conduit, cable tray and cable shields shall be properly bonded to the TMGB or telecommunications grounding busbar (TGB) as appropriate.
- C. The electrical panel serving an EF/TR/ER shall be grounded to that facility's TGB.
- D. All metallic conduits entering or exiting the EF/TR/ER shall be bonded to the TGB with a minimum #6AWG copper wire.
- E. Refer to Section 27-05-26 for additional details.

3.05 TESTING

- A. Devices shall be tested as part of the required system testing for the cabling they support.

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the ITS Telecomm group representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. None Required

END OF SECTION 27 11 00

SECTION 27 11 13 - COMMUNICATIONS ENTRANCE PROTECTION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Building entrance protectors and related accessories

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. Customer Owned Outside Plant Design Manual (BICSI)
- C. Telcordia GR-974, Issue 3
- D. The Cal Poly ITS Telecomm, Telecommunications Standards Document (TSD) and the Labeling, Design & Syntax Standard in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Shop drawings shall show the locations of protector blocks and splices, pair counts and cable designations at each installed entrance protector.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Identify each protector unit as to the details of the cable (other end of the cable, wire path, number of pairs, etc.) See the Cal Poly ITS Telecomm group Labeling, Design and Syntax Standard, Appendix B.
- B. Outdoor cables shall be labeled with outdoor rated, 1" wide, white with machine generated black lettering (DYMO type label) at each endpoint and entering and exiting each underground facility.
- C. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted.

2.02 BUILDING ENTRANCE TERMINAL

- A. Shall be used with entrance cabling that terminates in an EF/TR/ER.
- B. The units shall be 100 pair with input stub cable and 66 block style output.
- C. Terminal unit to incorporate a 26 AWG fuse link cable stub for 710 splicing to OSP cable.
- D. Uses type 4 protection modules.
- E. Must be UL listed. (See Fig. #142 in Appendix B)
- F. Approved Manufacturers: Commscope 489 Series, AVAYA or Cal Poly ITS Telecomm group approved equal.

2.03 SURGE PROTECTION MODULE

- A. Protectors shall utilize heat coils.
- B. Balanced 3-element gas discharge tube with fail-safe.
- C. Gas discharge tube is without backup gap.
- D. Built in Fail-safe device.
- E. Self-resetting sneak current protection (PTCs).
- F. Low capacitance (less than 10 pF) and low resistance (2.2-ohm PTCs).
- G. Protectors shall incorporate gold plated connections.
- H. Approved Manufacturer: Commscope Systimax or approved Cal Poly ITS Telecomm group equal

2.04 ENTRANCE PROTECTOR FOR HORIZONTAL COPPER UTP OSP STATION CABLE (VOICE)

- A. Six Pair, Cat3 with 110 IDC termination input and output
- B. UL 497 Listed for primary protection
- C. Uses type 4 protection modules.
- D. Approved Manufacturers: Tii Network Technologies / Porta Systems or Cal Poly ITS Telecomm group approved equal

2.05 ENTRANCE PROTECTOR FOR HORIZONTAL COPPER UTP OSP STATION CABLE (DATA)

- A. Four Pair, **CAT 6** with 110 IDC termination input and output

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- B. Supports 1 Gigabit & POE where Power and Data are on all 4-Pairs.
- C. Approved Manufacturer: Comscope, Marconi, Lucent or Cal Poly ITS Telecomm group approved equal

2.06 SPLICE CASE

- A. Splice case for terminating entrance OSP cable to Protector Panel stub cable
- B. All splices in a splice case shall be terminated with 3M 710 style connectors.
- C. Sized as required for pair counts and cable size.
- D. Shall be fire retardant, and re-enterable.
- E. End caps shall be sized as required for the number and size of the cables.
- F. All splices, splice cases, and connectors shall be installed per manufacturer's written instructions.
- G. Approved Manufacturer: 3M™ Building Riser Closure K&B Series or Cal Poly ITS Telecomm group approved equal
- H. Approved Manufacturer: 3M™ Building Riser Closure K&B Series or Cal Poly ITS Telecomm group approved equal
- I. Connect sheath to grounding bar (TGB) to provide cable sheath continuity.

PART 3 – EXECUTION**3.01 GENERAL**

- A. Location and placement of termination blocks, splice closures, splices and other related hardware shall be as shown on the Drawings or defined in the Cable Schedules.
- B. Final placement of termination blocks, splice cases, splices, OSP cable (routing) and other related hardware shall be approved in advance by the Cal Poly Telecomm group.
- C. For each OSP cable that extends beyond the drip line of the building, an appropriately sized entrance protector module shall be provided at both ends.

3.02 QUANTITIES

- A. Quantities of blocks, splice closures, splices, etc. shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of blocks, connectors, etc. necessary to terminate, cross-connect and patch the volume of cable described herein and shown on the Drawings.

3.03 INSTALLATION

- A. Building Entrance Terminals
 1. Submit Shop Drawings to the ITS Telecomm group for approval of block field, protector and splice case layouts and locations as well as OSP cable routing before starting work.
 2. Building Entrance Terminals shall only be installed within telecommunications spaces.
 3. Per NEC 800-90, Building Entrance Terminals shall be located as close as practical to its cable's point of entrance to a building.
 4. Cables from different buildings shall not share the same building entrance terminals.
 5. All building entrance terminals shall be fully populated with surge protection modules of the same make, model and manufacturer regardless of conductor count.

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6. Each protector shall be individually grounded to the TGB/TMGB or ground rod with a #6 AWG copper bonding conductor. (not daisy-chained)
 7. All building entrance terminals shall be labeled. (See Fig. #101 & 106 in Appendix B).
- B. Entrance Protectors for OSP CAT 3 Station Cable
1. Entrance Protectors for OSP Station Cable shall only be installed within EF/TR/ER telecommunications spaces.
 2. Each cable shall terminate on its own entrance protector.
 3. All entrance protectors shall be fully populated with surge protection modules of the same make, model and manufacturer.
 4. Each protector shall be individually grounded to the TGB/TMGB or ground rod with a #6 AWG copper bonding conductor. (not daisy-chained)
 5. All entrance protectors shall be labeled. See Section 27 05 53 and the Cal Poly ITS Labeling, Design & Syntax Standards in Appendix B for more detail. (See Fig. #101 & 106 in Appendix B)
- C. Splice Cases
1. Splice cases shall only be employed within a building and shall not be placed in a vault or other underground structure.
 2. OSP cables from separate buildings shall not share the same splice case.
 3. Each splice shall be individually grounded to the TGB/TMGB with a #6 AWG copper bonding conductor. (not daisy-chained)

3.04 GROUNDING & BONDING

- A. Each protector shall be individually grounded to the TGB/TMGB or ground rod with a #6 AWG copper bonding conductor. (not daisy-chained)
- B. Each splice case shall be individually grounded to the TGB/TMGB with a #6 AWG copper bonding conductor.
- C. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. Devices shall be tested as part of the required system testing for the cabling they protect and serve.

3.06 ACCEPTANCE

- A. Once the installation has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

The Project Record Drawings shall show the types and locations of all entrance protectors. Drawings shall include identifying information from the cable identification labels.

END OF SECTION 27 11 13

SECTION 27 11 16 - COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
1. Fixed 2 Post 19" x 7' equipment racks complete with all necessary installation hardware.
 2. Fixed 19" equipment cabinets complete with all necessary installation hardware.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES AND STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. ANSI/EIA-310-D (Racks, Panels, and Associated Equipment).
- C. NEBS-Telcordia GR-63-CORE Zone 4
1. Tested with 500 lbs. of equipment installed and 100 lbs. of simulated cable weight on the top.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
1. Shop drawings shall show the position of the equipment racks in the TR/ER. Racks shall be dimensioned, and the position of the rack or cabinet shall be dimensioned from (2) walls in each ER/TR. All TR/ER equipment rack layouts shall be reviewed and approved by the Cal Poly ITS Telecomm group prior to the ordering and/or installation of any product.
 2. Shop drawings for equipment racks shall also show the method of attachment to the floor and to any overhead ladder rack. All cable management raceways for equipment racks shall be shown on the shop drawings.
- C. Submit Manufacturer's Cut Sheets for the following:
1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets for approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Each rack shall require a ½" white, permanent, polyester label with black ink denoting the rack designation.
- B. Refer to Section 27 05 53 for additional details.
- C. Refer to the Cal Poly Labeling, Design & Syntax Standard in Appendix B.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 EQUIPMENT RACKS SHALL BE AS FOLLOWS:

- A. Racks shall be manufactured from aluminum extrusions.
- B. Each rack shall have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack shall assemble with bolt hardware. Equipment-mounting channels shall be threaded for easy assembly. The base angles shall be 3.88" x 6.0" x .375" thick and will be pre-punched for attachment to the floor.
- C. Equipment mounting channels shall be 3" deep x 1.265" wide x .25" thick and punched on the front and rear flange with the EIA-310-D Universal hole pattern.
- D. When assembled with top and bottom angles, equipment-mounting channels shall be spaced to allow attachment of 19" EIA rack-mount equipment. Attachment points shall be threaded with 12-24 roll-formed threads. The rack will include assembly and equipment-mounting hardware. Each rack shall include 50 each combination Phillips type, pan head, pilot point mounting screws.
- E. Top angle shall be 1.25" x 1.25" x .25" thick.
- F. The assembled rack shall measure 7' (84") high, 20.32" wide, and 15" deep. The sides of the equipment-mounting channels shall have threaded mounting points to allow attachment of vertical cable managers along the sides of the rack.
- G. The rack shall be rated for 1,000 lb. of equipment (minimum).

- H. The rack shall be UL Listed.
- I. Finish shall be (bare aluminum) silver/gray in color.
- J. Manufacturer/Product: Chatsworth Universal Rack or Cal Poly ITS Telecomm group approved equal.

2.03 VERTICAL RACK MOUNT WIRE MANAGEMENT SHALL BE AS FOLLOWS:

- A. Vertical Wire Manager
 - 1. A combination, double-sided vertical cable manager
 - 2. Front accessible side shall employ T-shaped cable fingers with rounded edges and include a contoured front door with easy-open knobs.
 - 3. Rear accessible side shall consist of adjustable rear cable rings with spin open latches
 - 4. Cable openings shall align with each rack-mount unit on the specified rack and pass 48 patch cords.
 - 5. Color is to be black.
 - 6. ***Install one (1) 12" W x 20.2" D vertical wire manager between each rack in every rack row.***
 - 7. ***Install two (2) 6" W x 20.2" D vertical wire manager, one at each end of every rack row.***
 - 8. Approved Manufacturer: Chatsworth 12" W x 20.2" D or Cal Poly ITS Telecomm group approved equal.
 - 9. Approved Manufacturer: Chatsworth 6" W x 20.2" D or Cal Poly ITS Telecomm group approved equal.
 - 10. ***Vertical wire management shall be coordinated to be easily mountable to equipment rack selected.***

2.04 HORIZONTAL RACK MOUNT WIRE MANAGEMENT SHALL BE AS FOLLOWS:

- A. Fiber/Copper Jumper Crossover Trough
 - 1. Double-sided, 4RU, 19" EIA rack mount horizontal jumper trough for patch cables. One Trough shall be installed at the top of every 19" rack cabinet.
 - 2. Radiused drop offs on each end of the tray.
 - 3. Color is to be black.
 - 4. Manufacturer/Product: ADC/Krone or Cal Poly ITS Telecomm group approved equal.
- B. Copper Cable Wire Manager
 - 1. ***Provide single-sided, 2RU, 19" EIA rack mount, horizontal Cable Managers as required. One shall be installed in the 2U just under the Jumper Cross-over Trough and one additional cable manager under every station patch panel.***
 - 2. Provides a side-to-side pathway that aligns with specified vertical managers.
 - 3. Color is to be black.
 - 4. Manufacturer/Product: Hubbell or Cal Poly ITS Telecomm group approved equal.

2.05 WALL MOUNTED EQUIPMENT RACKS AND CABINETS (REQUIRES PRIOR ITS TELECOMM APPROVAL)

- A. In new construction projects wall mounted equipment racks and cabinets shall not be used. All telecommunications related resource requirements shall be provided by and from an established EF/TR/ER.
- B. When the remodeling of existing structures is required, a TR/ER shall be constructed/established to exclusively house all telecommunications related equipment. In cases where the Cal Poly ITS Telecomm group agrees that it is not possible to create a separate TR/ER, the use of wall mounted and/or enclosed and lockable rack infrastructure may need to be considered. If so, such installations shall only be constructed using Cal Poly ITS Telecomm group reviewed and approved drawings and/or specifications. Final acceptance of the approved installation shall be the sole responsibility of the Cal Poly ITS Telecomm group.

PART 3 – EXECUTION

3.01 GENERAL

- A. Location and placement of equipment racks shall be as shown on the Drawings, defined in the specifications and schedules and preapproved by the Cal Poly ITS Telecomm group.
- B. Usage
 - 1. 2 Post racks are the only rack type that shall be used within designated ERs/TRs.
 - 2. Two post racks shall be used in all other secured, dedicated, locked, and environmentally controlled areas.
 - 3. Enclosed and lockable cabinets shall be used in environmentally controlled but public areas.
- C. Equipment racks and cabinets shall be assembled and installed as per the manufacturers' printed instruction and meet all Seismic Zone 4 requirements.
- D. Any excess length of bolts or threaded rods shall be trimmed to no more than ½" past the nut and de-burred. Preferred style of attachment is "drop-in" style threaded inserts if allowed.
- E. ***Project designs requiring enclosed and/or lockable cabinets shall be submitted to the Cal Poly ITS Telecomm group for review and approval prior to the purchase and/or installation of material.***

3.02 QUANTITIES

- A. Quantities and sizes of rack equipment and components shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of all materials necessary to accommodate the equipment and to terminate, cross connect and patch the volume of cable described in these specifications and schedules and shown on the Drawings.

- B. Quantities of Wire Managers
 - 1. Vertical Wire Managers
 - a. Rooms with 2 racks will have two 6" and one 12" vertical wire managers.
 - b. Rooms with 3 racks will have two 6" and two 12" vertical wire managers.
 - c. Rooms with 4 racks will have two 6" and three 12" vertical wire managers.
 - d. Rooms with 5 racks will have two 6" and four 12" vertical wire managers.
 - 2. Horizontal Wire Managers
 - a. Each 2-post rack shall include a minimum of two, 2RU Horizontal wire managers and one Fiber Radiused Cross-over Trough installed at the top
 - b. Wall cabinet or wall rack installations shall use 1RU wire management in such quantities as required by the Cal Poly ITS Telecommgroup.

3.03 INSTALLATION

- A. Follow manufacturer's installation instructions for compliance with referenced Seismic Zone 4 requirements.
- B. If any part of the project requires equipment racks to be installed in a raised floor application or requires auxiliary supports for which no Manufacturer's installation details are available allowing for compliance with the referenced seismic standards, the Contractor must provide an alternate installation approved by a structural engineer.
- C. Equipment racks and wall cabinets must be mounted and approved by the AHJ, as to appropriateness for anticipated equipment loads. Any proposed reinforcement shall be the responsibility of the Contractor.
- D. Wall cabinets and wall racks shall be mounted such that there are no obstructions or impediments to the full opening radius of the enclosure.
- E. Wall cabinets and wall racks shall be mounted such that they do not obstruct access to any other junctions, pull boxes, control panels, cabinets, etc.

3.04 GROUNDING & BONDING

- A. All racks and cabinets shall be individually grounded to the TGB/TMGB with a #6 AWG copper bonding conductor.
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. None required unless specified by AHJ or other contract requirements.

3.06 ACCEPTANCE

- A. Once the installation has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of installed equipment racks and (if allowed by the Cal Poly ITS Telecomm group) wall cabinets.

END OF SECTION 27 11 16

SECTION 27 11 19 - COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
1. ER/TR station cable termination system complete with all necessary installation hardware and labeling.
 2. Wall mounted termination systems shall not be allowed unless approved by the Cal Poly ITS Telecomm group at their sole discretion.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements must hold a current manufacturer's certification for each individual component they install.

1.03 CODES AND STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. TIA/EIA-568-B.1
- C. TIA/EIA-568-B.2 (including 568-B.2-10)
- D. ISO/IEC 11801 (including all current amendments)
- E. UL listed.
- F. Cal Poly ITS Telecomm group Labeling, Design and Syntax Standard in Appendix B.

1.04 SUBMITTALS

- A. Also refer to Section 27 00 00.
- B. Shop Drawings:
1. Shop drawings shall show the locations of all termination blocks and the location of each end of every cable that shall be terminated on them.
- C. Submit Manufacturer's Cut Sheets for the following:
1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval of the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Termination blocks shall be labeled as shown in the Labeling, Design and Syntax Standards in Appendix B. Details for terminal block labeling shall be reviewed and approved by a Cal Poly ITS Telecomm group representative. **(See Fig. #121 & 122 in Appendix B)**
- B. Patch panels shall be labeled with ½” white permanent polyester with black labeling. Detail shall be provided by a Cal Poly ITS Telecomm Labeling, Design & Syntax Standard in Appendix B. **(See Fig. #104, 105 & 147 in Appendix B)**
- C. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. **All patch panels shall be 48 Port. No other size is acceptable.**

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted.

2.02 RACK MOUNT PATCH PANELS

- A. The product shall be rack mountable in standard, 2 post 19” equipment rack. **(See Fig. #104 & 145 in Appendix B)**
- B. The product shall meet or exceed ANSI/TIA- 568-C.2 Category 6 Category specifications.
- C. The product shall be provided in 48-port configuration (only) featuring universal A/B labeling. **(See Fig. #104 & 105 in Appendix B)**
- D. Use 110 connector terminations on rear of panel allowing installation of 22 to 24 AWG cable.
- E. Be black powder covered high-strength aluminum panel with a removable rear mounted cable management bar.
- F. Shall include preprinted jack position numbers on the front panel and customizable cable ID labels above each position.
- G. Be backward compatible with Category 5e and 5 patch cords and cables.
- H. Include a 20-Year Extended Warranty as part of a registered structured cabling system.
- I. Approved Manufacturer: AMP, Inc. or Cal Poly ITS Telecomm approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Location and placement of wall- field shall be as shown on the Drawings or defined in these specifications and schedules.
- B. Supplied termination hardware shall accommodate 30% growth in cable terminations per floor.
- C. Termination hardware and patch panels shall be assembled and installed as per the manufacturers' printed instruction.
- D. *Do not install termination blocks until after their installation location has been approved by the Cal Poly ITS Telecomm group representative.***

3.02 QUANTITIES

- A. Quantities of wall field and components, patch panels, etc. shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of blocks, connectors, etc. necessary to terminate, cross-connect and patch the volume of cable described herein and shown on the Drawings.

3.03 INSTALLATION

- A. Installation Pattern
 - 1. *A minimum installation pattern shall be composed of one 4U rack mountable patch panel with 48 ports. Patch panels with other than 48 ports shall not be acceptable.***
 2. For additional station cables, add a second patch panel below the first. Include all required vertical and horizontal wire management. Increase the number of patch panels as necessary to a maximum of six per rack (192 cables).
 3. For additional station cables beyond 192, expand to a second equipment rack adding panels from the top down with a maximum of six 48 port patch panels (192 cables) and so on as necessary. Vertical and horizontal wire management shall be provided as required. ***(See Fig. #148 in Appendix B)***
 4. Sufficient patch panel space shall be provided to allow for a 30% growth in cable terminations per floor.
 5. See the Cal poly ITS Telecomm Labeling, Design and Syntax Standards in Appendix B.

3.04 GROUNDING & BONDING

- A. All wall patch panels shall be individually grounded to the TGB/TMGB with a #6 AWG copper bonding conductor.
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. Devices shall be tested as part of the required system testing for the cabling they support.

3.06 ACCEPTANCE

- B. Any deviation from the provided drawings or the Labeling, Design & Syntax Standards shall require submission and approval of a revised shop drawing by Cal Poly ITS Telecom group before the installation begins.
- C. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of installed cable termination hardware.

END OF SECTION 27 11 19

SECTION 27 11 20 - COMMUNICATIONS FIBER CABINETS, ADAPTERS AND CONNECTORS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. ER/TR fiber optic termination system complete with all necessary installation hardware.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES AND STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27-00-00.
- B. ANSI/TIA-568-C.3
- C. The Cal Poly ITS Telecomm Labeling, Design & Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Also refer to Section 27 00 00.
- B. Shop Drawings:
 - 1. Shop drawings shall show the locations of fiber optic terminations and the end points of each cable.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval of the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Fiber Cabinets shall be labeled with ½" white permanent polyester with black labeling. Detail shall be provided in the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
- B. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 FIBER OPTIC TERMINATION CABINET (RACK MOUNT) SHALL:

- A. Be constructed of 16 gauge steel with black powder coat finish
- B. Be fully enclosed 19" rack mountable cable management type patch cabinets.
- C. Have a Plexiglas locking front panel. Labeling and connectors shall be clearly visible with front panel open or closed.
- D. Have a lockable, removable rear access panel.
- E. Be modular and accept a variety of inter-changeable bulkheads as well as attenuators, capable of holding "ST", "SC" and "LC" barrel connectors.
- F. Have an integrated front cable management trough.
- G. Employ Trays and modules that provide a means to avoid exceeding the cable manufacturer's minimum bending radius to protect against crimping or overbending.
- H. Provide full rubber grommets for dust protection at all cable entry and exit points.
- I. Provide accommodation for labels identifying optical fiber splices and terminations.
- J. Approved Manufacturer: Panduit or Cal Poly ITS Telecomm approved equal.
- K. Approved Manufacturer: Panduit or Cal Poly ITS Telecomm approved equal.

2.03 FIBER OPTIC TERMINATION CABINET FOR HARSH ENVIRONMENTS SHALL: (WALL MOUNT-REMODEL ONLY)

- A. Constructed of 16 gauge steel with black powder coat finish
- B. Accommodate snap-in adapter plates and cassette modules.
- C. Provide removable, a lockable hinged door.
- D. Provide two-tier fiber storage hoops for fiber management.

- E. Provide top and bottom accesses have cable tie-downs/strain relief and full grommets.
- F. Provide lockable inner door that is removable.
- G. Meet NEMA 12 rated requirements.
- H. Approved Manufacturer/Product: Submit product for approval by the Cal Poly ITS Telecomm group.

2.04 FIBER OPTIC TERMINATION CABINET FOR SPACE CONSTRAINED TERMINATION SHALL:

- A. Be constructed of 16 gauge steel with white or black powder coat finish
- B. Accommodate snap-in bulkhead adapter plates.
- C. Include a lockable hinged door.
- D. Provide top and bottom access, have a cable tie-down/strain relief and full grommets.
- E. Approved Manufacturer: Lucent Technologies or Cal Poly ITS Telecomm approved equal.

2.05 BULKHEADS - BARREL CONNECTORS SHALL:

- A. Barrel connectors shall have ceramic alignment sleeves for single-mode and phosphor bronze sleeves for multimode.
- B. Bulkheads shall be removable from the front of the cabinet, and shall be of a tool-less design.
- C. Barrel connectors shall provide dust caps for every connector.
- D. Barrel connectors shall be type LC, ST, or SC as defined in ANSI/TIA/EIA-568. E. Max insertion loss across mated pair shall be less than .5db.
- E. Approved Manufacturer: Panduit (50 μ m Multimode) or Cal Poly ITS Telecomm group approved equal.
- F. Approved Manufacturer: Panduit (Single Mode) or Cal Poly ITS Telecomm group approved equal.

2.06 CONNECTORS (RISER/TIE/OSP/STATION FIBER OPTIC CABLE)

- A. Factory applied connectors on pigtails shall be available in 12 colors and shall be 6 feet in length each.
- B. All pigtails shall be fusion-spliced
- C. Shall have a maximum insertion loss across mated pair: less than .5db.
- D. Shall consist of optical Fiber: ST (62.5 μ m) Multimode: Color shall be Beige.
- E. LC (50 μ m) Multimode: Color shall be Aqua SC Single Mode: Color shall be Blue.
- F. Approved Cable Manufacturers: Commscope, Corning, Pirelli, Belden or Cal Poly ITS Telecomm group approved equal.
- G. Approved Pigtail Manufacturers: Gruber, Infinity, or Cal Poly ITS Telecomm group approved

equal.

2.07 FIBER FUSION SPLICE CASE W/ SPLICE TRAYS (OSP TO RISER FIBER)

- A. Shall require no special tools.
- B. Shall be re-enterable mechanical cable and O-ring equipped closure sealing system
- C. Shall provide multiple, expandable, split grommets, and wide opening cable ports.
- D. Shall accept a range of cable sizes.
- E. Approved Manufacturer: Preformed Line Products or Cal Poly ITS Telecomm approved equal.

2.08 GENERAL

- A. The Contractor shall place all optical fiber backbone cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
- B. Rack mounted cabinets shall be used in ERs/TRs. Wall mounted cabinets shall be used outside of ERs/TRs if design is approved by the Cal Poly ITS Telecomm group.
- C. Provide 50' slack loops at the ER/TR end of all OSP cables over 12 strands, and 20' slack loops at the ER/TR end of all other cables.
- D. Provide 72" of stripped fiber wrapped neatly at each fiber cabinet.
- E. Provide 72" of stripped fiber at the outlet end of any station fiber.
- F. All fiber terminations are to utilize color coded (blue for SC single mode and aqua for 50µm multimode duplex LC) connectors unless otherwise noted.
- G. Multiple fiber cables shall be installed into fiber cabinets as directed and approved by the Cal Poly ITS Telecomm group.
- H. Termination of fiber optic cables for use by the Fire Alarm System shall not to be terminated in an ER/TR/EF. Termination of fiber for the FACP end of Fire Alarm System cable shall be done directly in the fire alarm panel or other non-telecomm space location if directed by the AHJ.
- I. No patch cables shall be installed until after the fiber optic test reports have been reviewed and accepted by the Cal Poly ITS Telecomm group.

2.09 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

2.10 INSTALLATION

- A. Cabinets
 - 1. ***Rack location details (including elevation) for fiber cabinet mounting shall be approved by a Cal Poly ITS Telecomm group***

representative prior to installation.

2. After dressing the cable to its final destination, the sheath shall be removed to a point that allows the optical fiber strands to be splayed and terminated in a neat and uniform fashion.
 3. All fiber cabinets shall employ factory provided, appropriately sized grommets for all openings.
 4. All unused bulkhead openings shall be filled with blank plates.
- B. Connectors
1. ***Terminations of fiber pigtails shall be by fusion splices only.*** Fibers will be terminated in strict compliance with the manufacturer's printed instructions.
 2. Maximum length differential between terminated strands per bundle shall be 6". If the length does ***not*** meet this requirement the entire bundle must be re-terminated.
- C. Gel Filled Cables
1. All gel filled cables will require use of a gel blocking sealant at any point that the gel is exposed.
 2. Follow all manufacturers' specifications for proper application of gel block sealant.
- D. Fiber Optic Splices
1. In general, optical fiber cables shall not to be spliced unless otherwise noted.
 2. Where splicing is indicated, all optical fiber cable splicing shall be fusion spliced.
 3. Fiber optic cables shall never to be spliced in any outside or underground structure.
 4. Only one type of fiber (SM or MM) shall occupy each individual fiber splice tray.
 5. Mount splice case so it is fully supported on the wall, and available at a working height.
 6. Maintain sufficient slack to enable splice case to be removed from the wall for service.

2.11 GROUNDING & BONDING

- A. Any use of armored cable shall require the bonding of that shield to the TGB/TMGB with a #6 AWG copper bonding conductor.
- B. Refer to Section 27 05 26 for additional details.

2.12 TESTING

- A. Refer to Specification Section 27 08 23.

2.13 ACCEPTANCE

- A. The fiber cabinet shall be labeled per specifications. See Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B.
- B. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

2.14 RECORD (AS-BUILT) DRAWINGS

- A. None Required.

END OF SECTION 27 11 20

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. A complete copper twisted pair backbone cabling system to support voice circuit distribution as well as data communications with cables, termination hardware, splices, and necessary installation and supporting hardware.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. UL 444
- B. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- C. Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design & Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Shop drawings shall show cable routing details.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.
- D. Manufacturers Testing:
 - 1. Submit the testing results as required by Section 27 08 13.
 - 2. Multi-pair copper riser cables: The Contractor shall submit two (2) sets of the manufacturer's test results for continuity, shorts and breaks.

1.05 IDENTIFICATION

- A. Machine generated, 1", nylon labels with black lettering shall be placed on all copper backbone and riser cables.

- B. Labels containing a unique cable ID designator developed by the contractor using the Cal Poly ITS Labeling, Design & Syntax Standard in Appendix B and approved by a Cal Poly ITS Telecomm group shall be placed on both ends of all cables, 6 inches from the termination and/or terminal block, and in all pull boxes in the pathway.
- C. ***Subsequent to placing and terminating cables, the Contractor shall place the appropriate labels as indicated above.***
- D. If at any time during the job the label becomes illegible or removed for whatever reason, the Contractor shall immediately replace it with a new label at the Contractor's expense.
- E. ***All labels shall be easily accessible, both physically and visually, upon completion of the job.***
- F. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. Backbone Cable as defined in this section shall be intra-building riser cable for use between EFs/TRs/ERs
- B. OSP Cable as defined in Section 27 13 14 is an inter-building cable for use between EFs.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 COPPER CABLES – GENERAL

- A. Cable jacket marking: Must be legible and shall contain the following information:
 - 1. Manufacturer's name
 - 2. Copper Conductor Gauge
 - 3. Pair Count
 - 4. UL and CSA listing
 - 5. Manufacturer's Trademark
 - 6. Category rating
 - 7. Sequential foot markings, in one-foot increments

2.03 COPPER CABLE (BACKBONE)

- A. Cable jacket shall be white, plenum rated, with black lettering.
- B. Cable must be ARMM riser rated.
- C. Cable construction specifications:
 - 1. Core wrap – Polypropylene Film.
 - 2. Shield – Corrugated Aluminum tape bonded to riser rated jacket.

- D. The cables consist of 22 AWG foam polyethylene insulated conductors with plenum rated skin formed into binder groups of 25 pairs using standard PIC color coding.
- E. Approved Manufacturer: Superior Essex or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Location and placement of backbone cables shall be shown on the Drawings. ***Submit Shop Drawings to the ITS Telecomm group for approval of block field, protector and splice case layouts and locations as well as OSP cable routing before starting work.***
- B. Backbone copper cabling shall not share pathways with backbone fiber cabling or any horizontal cable unless approved in advance by the Cal Poly ITS Telecomm group.
- C. Backbone copper cabling shall be installed point to point. ***Terminating a subgroup of conductors from a cable within a conduit and continuing to another location shall not be allowed.***
- D. ***Absolutely no in-line splicing of backbone copper cabling shall be allowed.***
- E. Contractor is to verify (in advance) sufficient end to end pathway fill ratios for cable runs prior to installation.
- F. ***No cross-connects shall be installed until after the backbone cable test reports have been reviewed and accepted by the Cal Poly ITS Telecomm group representative. All cross-connects shall typically be installed by the Cal Poly ITS Telecomm group.***

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Cabling:
 - 1. Unless otherwise noted, all backbone cables shall be routed through continuous conduit from point to point.
 - 2. All backbone cable, once exposed, shall be provided with appropriate support.
 - 3. ***At the same time cable is pulled into a conduit also install a pull rope to facilitate future cable pulls along those pathways. Pull rope shall be (minimum) nylon ¼" with 600 lb. pulling tension.***
 - 4. Cables running on ladder racking within an EF/TR/ER shall be neatly placed and lashed to the horizontal and vertical ladder racking with wire ties at every rung.
- B. Cable Terminations
 - 1. All riser cables shall be "punched down" on 66 blocks in the EF/TR/ER.
 - 2. Cable pair twists shall be maintained up to within 1/2 in. of the point of termination for backbone cables. For other backbone cables, maintain twists as close as practicable to the point

of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.

3. All terminations shall follow industry standard uniform color codes.

3.04 GROUNDING & BONDING

- A. All termination locations for backbone copper cable shall bond the cable shield to the TGB/TMGB with a #6 AWG copper bonding conductor.
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. For testing details see Section 27 08 13

3.06 ACCEPTANCE

- A. Upon receipt of the Contractor's documentation of testing, the Cal Poly ITS Telecomm group representative shall review/observe the installation and may randomly request tests of the cables/wires installed. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. *The Project Record Drawings shall show the types and locations of all backbone cabling. Drawings shall include identifying information from the cable identification labels.*

END OF SECTION 27 13 13

SECTION 27 13 14 - COMMUNICATIONS COPPER OSP CABLING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. A complete copper twisted pair outside plant (OSP) backbone cabling system to support voice circuit distribution as well as data communications with cables, termination hardware, splices, and necessary installation and supporting hardware.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27-00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. Customer Owned Outside Plant Design Manual (BICSI)
- C. The Cal Poly ITS Telecommunications Standards Document

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Shop drawings shall show the OSP backbone pathways, locations and type of terminal blocks, entrance protectors, pair counts and cable designations at termination points.
 - 2. Shop drawings shall show the layout of the distribution frames in the EF and the TRs/ERs with pair counts by each wiring block.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecommgroup.
- D. Manufacturers Testing:
 - 1. Submit the testing results as required by Section 27 08 13.

1.05 IDENTIFICATION

- A. Outdoor cables must be labeled with 1" white nylon labels with black machine generated lettering within 18" of all conduit endpoints and both cable endpoints. Within all

underground structures larger than 3' in any dimension, label each cable as it enters the structure, and when it exits the structure.

- B. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 COPPER OSP CABLES – GENERAL

- A. Cable jacket marking: Must be legible and shall contain the following information:
 1. Manufacturer's name
 2. Copper Conductor Gauge
 3. Pair Count
 4. UL and CSA listing
 5. Manufacturer's Trademark
 6. Category rating
 7. Sequential foot markings, in one-foot increments

2.03 COPPER OSP CABLE (BACKBONE CABLE)

- A. Cables shall be specifically PE89, gel filled, qualpeth sheathed with aluminum shield, 22 AWG, multi- pair cables.
- B. See one line diagram in the Drawings for required paircounts.
- C. Minimum performance specifications: The cables shall meet the requirements of ANSI/EIA/TIA-568B for 100- Ohm UTP Multi-pair Backbone Cable.
- D. Approved Manufacturer: Superior Essex or Cal Poly ITS Telecomm group approved equal.

2.04 COPPER OSP CABLE (CAT 6 STATION CABLE)

- A. Cable shall be Category 6 UTP Cable, outdoor, flooded gel, black jacket, 4 pair count.
- B. Approved Manufacturer: Commscope or Cal Poly ITS Telecomm group approved equal.

2.05 COPPER OSP CABLE (CAT 3 STATION CABLE)

- A. Cable shall be Category 3 UTP Cable, outdoor, black jacket with a rip cord, 6 pair count.
- B. Cable shall be suitable for direct burial, gel filled, with an aluminum shield.
- C. Approved Manufacturer: Superior Essex or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Location and placement of termination blocks and cable types shall be as shown on the Drawings.
- B. Do not install cross-connects until after the cable test reports have been accepted by the Cal Poly ITS Telecomm group representative. *Cross-connects are typically installed by the Cal Poly ITS Telecomm group.*

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. OSP Cable Installation
 - 1. Install OSP cables in accordance with all Specifications and Drawings.
 - 2. All OSP cables shall run from the termination locations indicated on the copper cable riser diagram or site plan through the dedicated pathways and spaces identified in the Telecommunications Drawings and into their respective EF/TR/ER.
 - 3. All OSP cables shall be terminated on protector panels in a TR/ER or EF.
 - 4. Cables terminating at an outside endpoint shall be required to have an entrance protector covering all pairs, including spares.
 - 5. Cables running on ladder racking within an EF/TR/ER shall be neatly placed and lashed to the horizontal and vertical ladder racking with wireties at every rung.
 - 6. At the same time cable is pulled into a conduit also install a pull rope to facilitate future cable pulls along all pathways. Pull rope to be (minimum) nylon ¼" 600 lb. pulling tension.
 - 7. Observe all manufacturers' written specifications, specifically in regard to pulling tensions for cables and allowable methodologies for installation.
- B. Cable Terminations
 - 1. Cable pair twists shall be maintained up to within ½ in. of the point of termination.
 - 2. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.
 - 3. All terminations shall follow industry standard uniform color codes.

4. *Submit Shop Drawings to the ITS Telecomm group for approval of block field, protector and splice case layouts and locations as well as OSP cable routing before starting work.*

- C. Gel Sealant
 - 1. All gel filled cables shall require use of a gel blocking sealant at any point that the gel is exposed.
 - 2. Follow all manufacturers' specifications for proper application of gel block sealant.

3.04 GROUNDING & BONDING

- A. Each OSP cable shall be grounded with a Shield Bond Connector via a #6 AWG copper wire to the TGB/TMGB or ground rod if at an outside endpoint.
- B. Each protector shall be individually grounded via a #6 AWG copper wire to the TGB/TMGB or ground rod if at an outside endpoint.
- C. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. For testing details see Section 27 08 13

3.06 ACCEPTANCE

- A. 100% of the copper pairs tested per cable shall meet requirements for the whole of the installation to be accepted.
- B. Upon receipt of the Contractor's documentation of cable testing, the Cal Poly ITS Telecomm group representative shall review/observe the installation and randomly request tests of the cables/wires installed. Once the installation and testing has been completed and the campus telecommunications representative is satisfied that all work is in accordance with the Contract Documents, the representative shall notify the Contractor and/or campus project manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all OSP cabling, and all OSP termination points. Drawings shall include identifying information from the cable label.
- B. Provided documentation shall include Butterfly Drawings for each vault, detailing specific conduit utilization for each cable.

END OF SECTION 27 13 14

SECTION 27 13 23 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Optical fiber backbone cabling

1.02 QUALITY ASSURANCE

- A. Refer to Section 27-00-00 for general details.
- B. As noted in Section 27-00-00, all contractors and installers working on structured cabling system elements must hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27-00-00.
- B. TIA-492-AAAD
- C. ITU-T G.652D
- D. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Also refer to Section 27 00 00.
- B. Shop Drawings:
 - 1. Shop Drawings shall show the locations where cables are to be routed and where terminating hardware is to be installed.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval of the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. All fiber optic backbone and riser cables must be labeled with 1" nylon label with black machine generated lettering at each endpoint and each time it enters or exits an underground facility or vault.
- B. All labels shall be easily accessible, both physically and visually, upon completion of the job.**
- C. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. CMP: Communications Plenum Cable
- B. CMR: Communications Riser Cable
- C. MPP: Multipurpose Plenum Cable
- D. OFNP: Optical Fiber Nonconductive Plenum Cable
- E. OFCP: Optical Fiber Conductive Plenum Cable
- F. LSZR: Low Smoke Zero Halogen Rated Cable
- G. OM1: Defined by ISO 11801 & TIA-492-AAAA, 62.5/125 μm multimode fiber.
- H. OM2: Defined by ISO 11801 & TIA-492-AAAB, 50/125 μm multi-mode fiber.
- I. OM3: Defined by ISO 11801 & TIA-492-AAAC, laser-optimized 50/125 μm multi-mode fiber.
- J. OM4: Defined by TIA-492-AAAD, laser-optimized 50/125 μm multi-mode fiber.
- K. OS1: Defined by ITU-T G.652A/B/C/D, tight buffered 9 μm indoor single mode fiber.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.02 FIBER OPTIC CABLES – GENERAL

- A. Cable jacket marking: Must be legible and shall contain the following information:
 - 1. Manufacturer's name and/or trademark
 - 2. Strand count
 - 3. Core Type
 - 4. Core Count
 - 5. UL listing
 - 6. Sequential distance markings, in one-foot increments
- B. All multimode fiber (UON) shall be OM4, 50 μm , laser optimized, multimode fiber.
- C. All single mode shall be zero water peak single mode fiber.

2.03 OPTICAL FIBER PLENUM RISER CABLE

- A. Non-armored, gel free, plenum rated distribution cable
- B. Jacket color for 50 μm multimode fiber shall be aqua.
- C. Jacket color for single mode fiber shall be yellow.
- D. Approved Manufacturer: Commscope or Cal Poly ITS Telecomm group approved equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. Backbone (Non OSP) fiber optic cables are for use between telecommunications facilities within the same building.
- B. Location, fiber count and placement detail for all fiber optic cables shall be as shown on the Drawings.
- C. Provide 20' slack loops at the TR end of all backbone fiber optic cables.
- D. Provide 72" of stripped strands fiber wrapped neatly at each fiber cabinet.
- E. Insure all fiber optic cables as installed are not subject to strain, and that correct bend radiuses are maintained at all times.
- F. Do not combine terminations of fiber optic cables leading to different endpoints into a single cabinet. Each distribution, riser, OSP or Fire Alarm serving cable shall require their own, dedicated fiber termination cabinet.
- G. Each fiber optic riser cable shall be placed within one cell of innerduct per Section 27 05 33
- H. Fiber optic cables and copper cables shall not share conduit or innerduct.
- I. Do not terminate fiber until after the rack locations and elevations of fiber cabinets have been approved by the Cal Poly ITS Telecomm group representative.
- J. Patch cables shall not be installed until after the fiber optic test reports have been approved by the Cal Poly ITS Telecomm group representative. *The Cal Poly ITS Telecomm group typically installs all patch cables.*

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Optical Fiber Backbone Cables:
 - 1. Provide support for vertical runs of fiber optic riser cables.
 - 2. Route fiber optic cables over telecom ladder racking.
 - 3. Route fiber optic cables together as a single bundle, not to be combined with copper or coax cabling.
 - 4. Installation of all fiber optic cables shall require the use of a breakaway swivel rated to the cable manufacturer's written specifications for pull strength.
 - 5. Follow all manufacturers' specifications for installation.
- B. Connector Installation
 - 1. Fiber Optic cabling shall be terminated using fusion-spliced pigtails **only**.
 - 2. Maximum length differential between terminated strands per bundle shall be 2". If the length does not meet this requirement the entire bundle must be re-terminated.

C. Slack Loop

1. Slack loop shall be mounted on the wall, above ladder rack height.
2. Slack loop location shall be designated by the Cal Poly ITS Telecomm group representative.

3.04 GROUNDING & BONDING

- A. Any use of armored cable shall require the bonding of that shield to the TGB/TMGB with a #6 AWG copper bonding conductor.
- B. Refer to Section 27-05-26 for additional details.

3.05 TESTING

- A. Refer to Specification Section 27 08 23.

3.06 ACCEPTANCE

- A. 100% of the fiber tested must meet requirements for the whole of the fiber installation to be accepted.
- B. Upon receipt of the Contractor's cable testing documentation, the Cal Poly ITS Telecomm group representative shall review/observe the installation and/or randomly request tests of the cables installed. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all fiber optic cabling and fiber optic termination points. Drawings should include identifying information from the cable labels.

END OF SECTION 27 13 23

SECTION 27 13 24 - COMMUNICATIONS OPTICAL FIBER OSP CABLING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. OSP optical fiber backbone cabling system

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design & Syntax Standards in Appendix B.
- C. Customer Owned Outside Plant Design Manual (BICSI)

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Shop drawings shall show the locations where cables are to be routed and where terminating hardware is to be installed.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. Outdoor cables shall be labeled with a 1" wide machine-generated, white nylon label with characters in black ink, within 18" of all conduit endpoints as well as on both cable endpoints. Within all underground structures larger than 3' in any dimension, label each cable as it enters and exits the structure.
- B. Refer to Section 27 05 53 for additional details.
- C. Refer to the Cal Poly ITS Telecomm group Labeling, Design & Syntax Standards in Appendix B.

1.06 DEFINITIONS

- A. CMP: Communications Plenum Cable
- B. CMR: Communications Riser Cable
- C. MPP: Multipurpose Plenum Cable
- D. OFNP: Optical Fiber Nonconductive Plenum Cable
- E. OFCP: Optical Fiber Conductive Plenum Cable
- F. LSZR: Low Smoke Zero Halogen Rated Cable
- G. OM1: Defined by ISO 11801 & TIA-492-AAAA, 62.5/125 μm multi-mode fiber. (old Campus Standard)
- H. OM2: Defined by ISO 11801 & TIA-492-AAAB, 50/125 μm multi-mode fiber.
- I. OM3: Defined by ISO 11801 & TIA-492-AAAC, laser-optimized 50/125 μm multi-mode fiber.
- J. OM4: Defined by TIA-492-AAAD, laser-optimized 50/125 μm multi-mode fiber (new Campus Standard)
- K. OS2: Defined by ITU-T G.652C/D, loose tube 9 μm outdoor loose tube single mode fiber.
- L.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted.

2.02 FIBER OPTIC CABLES – GENERAL

- A. Cable jacket marking: Must be legible and shall contain the following information:
 - 1. Manufacturer's name and/or trademark
 - 2. Strand count
 - 3. Cable Type
 - 4. Pair Count
 - 5. UL listing
 - 6. Sequential distance markings, in one foot increments
- B. All single-mode shall be zero water peak single-mode fiber

2.03 SINGLE MODE OPTICAL FIBER OSP CABLE

- A. Non-Armored Jacket shall be MDPE, with strength elements and zip cord immediately underneath.
- B. Internal structure shall include water swellable tape layer and 2 mm gel filled buffer tubes.
- C. Fibers shall be contained in loose tube construction surrounding a central dielectric strength member.

- D. Shall be 12 strands per subunit, with the required number of single-mode fibers in one overall jacket.
- E. Jacket color shall be black.**
- F. Approved Manufacturers: Commscope, Corning or Cal Poly ITS group approved equal.

2.04 SINGLE MODE OPTICAL FIBER INDOOR/OUTDOOR CABLE

- A. Non-Armored Jacket shall be plenum and OSP rated.
- B. Cable shall have aramid yarn and zip-cord immediately underneath jacket.
- C. Internal structure shall include water barrier layer and a central dielectric strength member.
- D. Jacket color shall be black.**
- E. Approved Manufacturer: Commscope or Cal Poly ITS Telecomm group approved equal.

2.05 SINGLE MODE OSP FIBER INDOOR PLENUM-RATED CABLE

- A. Shall have a non-armored jacket and be plenum rated.
- B. Shall have aramid yarn and zip cord immediately under the cable jacket.
- C. Shall have an internal structure that includes water barrier and a central dielectric strength member.
- D. Jacket color shall be yellow.**

PART 3 – EXECUTION

3.01 GENERAL

- A. OSP fiber optic cables shall be used between telecommunications facilities in different buildings, or for any connections that are subject to moisture.
- B. Location, fiber count and placement detail for all fiber optic cables shall be as shown on the Drawings.
- C. OSP cable shall be run through continuous conduit and/or manholes until it is exposed in a telecommunications space where it is to be terminated.**
- D. Provide 50' slack loops at the EF/TR/ER end of all OSP fiber optic cables over 12 strands. OSP fiber optic cables under 12 strands shall have 20' slack loops.
- E. Provide 72" of stripped fiber strands wrapped neatly at each fiber cabinet.
- F. Insure all fiber optic cables as installed are not subject to strain, and that correct bend radiuses are maintained at all times.
- G. Fiber optic cables and copper cables shall not share conduit or innerduct unless approved in advance by the Cal Poly ITS Telecomm group.
- H. Do not terminate fiber until after the rack locations and elevations of fiber cabinets have been accepted by the Cal Poly ITS Telecomm group representative.**
- I. Do not install patch cables. After the fiber optic cable test reports have been accepted by the Cal Poly ITS Telecomm group representative the ITS Telecomm group shall install all patch cables.**

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the

correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. A. Optical Fiber OSP Cables:
 - 1. Provide support for vertical runs of fiber optic riser cables.
 - 2. Route fiber optic cables over telecom ladder racking.
 - 3. ***Route fiber optic cables together as a single bundle, not to be combined with copper or coax cabling.***
 - 4. Installation of all fiber optic cables shall require the use of a breakaway swivel rated to the cable manufacturer's written specifications for pull strength.
 - 5. Follow all manufacturers' specifications for installation.
- B. B. Connector Installation
 - 1. Terminate both ends of each fiber with an appropriate fusion spliced pigtail. Fibers shall be terminated in strict compliance with the manufacturer's printed instructions.
 - 2. ***Maximum length differential between terminated strands per bundle shall be 6". If the length does not meet this requirement the entire bundle must be re-terminated.***
- C. Slack Loop
 - 1. Slack loop shall be coiled and mounted on the wall. ***(See Fig. #139 in Appendix B)***
 - 2. Slack loop location shall be designated by the Cal Poly ITS Telecomm group representative.
- D. Underground
 - 1. OSP fiber optic cables shall be lashed to and supported by cable management arms within any underground facilities.
 - 2. Outdoor cables shall be labeled with a 1", machine generated, white nylon label, with characters in black ink at each location, within 12" of where it enters or exits in each underground facility.
 - 3. ***At each vault, each fiber optic OSP cable shall make one complete horizontal wrap of the vault before continuing along its pathway.***

3.04 GROUNDING & BONDING

- A. None Required

3.05 TESTING

- A. Refer to Specification Section 27 08 23.

3.06 ACCEPTANCE

- A. ***100% of the fiber plant shall be tested and shall meet all requirements and specifications as stated by the manufacturer and in the Contract Documents to receive final approval by the Cal Poly ITS Telecomm group.***
- B. Upon receipt of the Contractor's documentation of cable testing, the Cal Poly ITS Telecomm group representative will review/observe the installation and randomly request tests of the cables installed.

Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all fiber optic cabling and fiber optic termination points. Drawings shall include identifying information as indicated on the cable labels.
- B. Provided documentation shall include butterfly drawings for each vault, detailing specific conduit utilization for each cable.

END OF SECTION 27 13 24

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SECTION 27 15 13 - STRUCTURED CABLE SYSTEM (SCS)

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. A complete structured cabling system composed of Category 6 unshielded twisted pair station cabling system with all cables, termination hardware, outlets and necessary installation and supporting hardware in accordance with the strictest manufacturer written recommendation, the specification, and Cal Poly ITS Telecomm Labeling, Design & Syntax Standards in Appendix B.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecom group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. None Required
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.
- D. Manufacturers Testing:
 - 1. Submit as testing results as required by Section 27 08 13.
- E. Documentation supporting the proposed warranty and all terms and conditions.
- F. All certifications (individual and company) as required by the guarantor of the above-mentioned warranty shall be submitted. These certifications shall only include those persons with direct association with this project and includes the expiration date and full name of each individual for which the certification is issued.

1.05 IDENTIFICATION

- A. Cable labels shall be placed on both ends of all cables.**
- B. 1" white nylon with black lettering cable labels.
- C. Labels containing a unique cable number shall be placed on both ends of all cables, 6 inches from the termination and/or terminal block. (See the Cal Poly ITS Telecomm group Labeling, Design and Syntax Standard in Appendix B)
- D. Subsequent to placing and terminating cables, the Contractor shall place the appropriate cable label on all cables as defined above.**
- E. If at any time during the job the cable label becomes illegible or removed for whatever reason, the Contractor shall immediately replace it with a duplicate pre-printed cable label at the Contractor's expense.**
- F. All cable labels shall be easily accessible, both physically and visually, upon completion of the job.**
- G. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. N/A

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.
- B. All components used in horizontal cabling systems shall be warranted for a minimum period of 20 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/EIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and available for each cable system.
 - 1. Warranty shall be guaranteed by a single reputable manufacturer:
 - a. AMP, Inc. or Cal Poly ITS Telecomm group approved equal

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted, unless specifically noted otherwise.

2.02 COPPER STATION CABLES – GENERAL

- A. Cable jacket marking: Must be legible and shall contain the following information:
 - 1. Manufacturer's name and/or trademark
 - 2. Copper Conductor Gauge
 - 3. Pair Count
 - 4. UL listing
 - 5. Category rating
 - 6. Sequential distance markings, in one-foot increments

2.03 CAT 6 HORIZONTAL CABLE

- A. UTP Station Cable for voice and data: 4 unshielded twisted pairs of 23 AWG solid copper conductors. Individually insulated conductors under a commonsheath.
- B. Cable must be plenum rated.**
- C. Cable must meet requirements for Category 6 of ANSI/TIA/EIA-568
- D. Station cable jacket shall be **white**.
- E. Approved Manufacturers: Commscope, Belden, Hitachi, AMP, Belkin or Cal Poly ITS Telecomm group approved equal

PART 3 – EXECUTION

3.01 GENERAL

- A. Location and placement of termination blocks, patch panels and other distribution hardware shall be shown on the Drawings or defined therein.
- B. All cross-connects shall be installed by the Cal Poly ITS Telecomm group after all station cable test reports have been reviewed and approved.
- C. Station cable shall be designed and installed such that the installed length (Permanent Link) is a maximum of 290 feet from faceplate to the patch panel in the ER/TR. (See Fig. #161 in Appendix B)**

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. The Contractor shall install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical couplers installed between the cable points of origin and termination.
- B. Unless otherwise noted, all cables shall be routed through the building ITS Telecomm cable tray or conduit.
- C. All horizontal cables shall be plenum rated except where run under the slab or exposed to moisture. Cables run under the slab or exposed to moisture shall be OSP cable, see 27-13-14 for more details.
- D. Non-telecomm cable runs shall not be tie-wrapped to any Structured Cable System supporting devices (including cable trays, wire basket, conduit, etc.), except when supported by ladder racking within the EF/TR/ER.**
- E. At the same time cable is pulled into a pathway, also install a pull string to facilitate future cable pulls.
 - 1. Pull string shall be nylon with 210 lb. pulling tension. Pull string is to be tied off at each end.
- F. Install station cabling, faceplates and jacks as detailed in the Specifications and Drawings. The typical configuration for faceplates shall be three unshielded twisted pair (UTP) cables of 4 pairs each, in non-residential spaces unless otherwise noted. **Structured cable shall be terminated to a jack or plug of the proper Category using the 568A termination standard.** (See the Cal Poly ITS Telecomm Labeling, Design & Syntax Standards in Appendix B)

G. Non-Typical Station Outlets:

1. Security Cameras, Wireless Access Point Locations, Wall Phones, Card Access Devices, Key Boxes and other special use outlets/faceplates shall require differing quantities of station cables, have different termination requirements and shall require approval in writing in advance by the Cal Poly ITS Telecomm group.
2. See section 27-15-43 for termination details, and see Drawings for specific location details.

H. Terminate all four pairs of each cable on one faceplate 8p8c jack.

- I. Leave 15" of slack for each cable measured from the face of the wall, at each jack location.
- J. Leave 6" of slack at any transition or pull point to maintain cable bend radius and prevent damage to the cable.
- K. Leave 12" of slack for the pull string at the faceplate end, and 36" of slack at the far end of the pathway.

L. Cable Termination

1. Station cable shall terminate in a specific EF/TR/ER designated on the Drawings to serve that location.
2. Station cable shall terminate on the proper distribution panel in the appropriate TR/ER equipment rack.
3. Leave a minimum of 6" of slack for each cable at the point of termination.
4. Maintain pair twists of Station cable up to the point of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.
5. Do not bend Station cables to a radius of less than four (4) times the cable diameter.
6. Cabling installation shall meet all manufacturer's written instructions.
7. See Specification Section 27 11 19 for more detail on patch panel terminations.

3.04 GROUNDING & BONDING

- A. N/A
- B. Refer to Section 27 05 26 for additional details.

3.05 TESTING

- A. For testing details see Section 27 08 13.

3.06 ACCEPTANCE

- A. Upon receipt of the Contractor's documentation of testing, Cal Poly ITS Telecomm group representatives will review/observe the installation and may randomly request tests of the cables/wires installed. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all Station cabling. Drawings shall include identifying information from the cable identification labels.

END OF SECTION 27 15 13

SECTION 27 15 14 - AUDIO VISUAL STATION CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. A complete Category 6 unshielded twisted pair Station/Structured Cabling System with all cables, termination hardware, outlets and necessary installation and supporting hardware in accordance with the strictest manufacturer written recommendation, Specification, and Cal Poly ITS Telecomm group, Telecommunications Standards Document.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document (TSD) and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. None Required
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.
- D. Manufacturers Testing:
 - 1. Submit as testing results as required by Section 27 08 13.
- E. Documentation supporting the proposed warranty and all terms and conditions.
- F. All certifications (individual and company) as required by the guarantor of the above-mentioned warranty shall be submitted. These certifications shall only include those persons with direct association with this project and includes the expiration date and full name of each individual for which the certification is issued.

1.05 IDENTIFICATION

- A. Cable labels shall be placed on all cables.
- B. Cable labels shall be 1" white nylon with black lettering.

- C. Labels containing a unique cable number shall be placed on both ends of all cables, 6 inches from the termination and/or terminal block.
- D. Subsequent to placing and terminating cables, the Contractor shall place the appropriate cable label as noted above.
- E. If at any time during the job the cable label becomes illegible or removed for whatever reason, the Contractor shall immediately replace it with a duplicate pre-printed cable label at the Contractor's expense.
- F. All cable labels shall be easily accessible and both physically and visually accessible, upon completion of the job.
- G. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. *The Cal Poly ITS Telecomm group is an entity that is part of Enterprise Systems and reports to the Chief Information Officer (CIO). Classroom Technologies is an entity separate from ITS Telecomm but is also part of Enterprise Systems. Any work discussed in this document only relates to the ITS Telecomm portion of any project and our network support of Audio-Visual Cabling. Refer to Classroom Technologies' Standards Documents for information and direction regarding all other work in the area of Classroom Technology at <http://www.MDS.calpoly.edu>.*

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.
- B. All components used in horizontal cabling systems shall be warranted for a minimum period of 20 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/EIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and available for each cable system.
 - 1. Warranty shall be guaranteed by a single reputable manufacturer such as AMP, Inc. or a Cal Poly ITS Telecomm group approved equal.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item shall not be permitted, unless specifically noted otherwise.

2.02 COPPER STATION CABLES – GENERAL

- A. Cable jacket marking: Must be legible and shall contain the following information:
 - 1. Manufacturer's name and/or trademark
 - 2. Copper Conductor Gauge
 - 3. Pair Count
 - 4. UL listing
 - 5. Category rating
 - 6. Sequential distance markings, in one-foot increments

2.03 CAT 6 HORIZONTAL CABLE

- A. UTP Station Cable for voice and data: 4 unshielded twisted pairs of 23 AWG solid copper conductors. Individually insulated conductors under a commonsheath.
- B. Cable must be plenum rated.
- C. Cable must meet requirements for Category 6A of ANSI/TIA/EIA-568
- D. Station cable jacket shall be green.
- E. Approved Manufacturers: Commscope, Belden, Hitachi, AMP, Belkin or Cal Poly ITS Telecomm group approved equal

PART 3 – EXECUTION

3.01 GENERAL

- A. Location and placement of termination blocks, patch panels and other distribution hardware shall be shown on the Drawings or defined therein.
- B. Cross-connects shall be installed by the Cal Poly ITS Telecomm group after the horizontal cable test reports have been reviewed and accepted by the Cal Poly ITS Telecomm group.
- C. Ethernet Station Cables for Audio Visual use are to be designed and installed so that the installed length (Permanent Link) is a maximum of 290 feet from jack to jack. **(See Fig. #161 in Appendix B)**

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings shall be illustrative only and shall indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. The Contractor shall install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical couplers installed between the cable points of origin and termination.
- B. Unless otherwise noted, all cables shall be routed through the telecom cable tray or conduit in each building.
- C. All horizontal cables shall be plenum rated except where run under the slab or exposed to moisture. Cables run under the slab or exposed to moisture shall be OSP cable, see 27-13-14 for more details.
- D. Non-telecomm cable runs shall not be tie-wrapped to any supporting devices (including cable trays, wire basket, conduit, etc.).
- E. At the same time cable is pulled into a pathway, also install a pull string to facilitate future cable pulls.
 - 1. Pull string shall be nylon with 210 lb. pulling tension. Pull string shall be tied off at each end.
- F. Terminate all four pairs of each cable on one outlet jack.
- G. Leave 12" of slack for each cable measured from the face of the wall, at each jack location.
- H. Leave 6" of slack at any transition or pull point to maintain cable bend radius, and prevent damage to the cable.

- I. Leave 12" of slack for the pull string at the faceplate end, and 36" of slack at the far end of the pathway.
- J. Cable Termination.
 - 1. Station cabling for audio/video outlets shall be installed point to point between AV device locations as designated on the Drawings. ITS Telecomm faceplate jacks shall be the "demark" connection location for Classroom Technology to gain access to the Ethernet. **(See Fig. #166 & 167 in Appendix B)**
 - 2. Leave 6" of slack for each cable at the point of termination.
 - 3. Maintain pair twists of Horizontal cable up to within 1/2 inch of the point of termination. Under no circumstances shall cable pairs be untwisted or otherwise altered prior to termination.
 - 4. Do not bend horizontal cables to a radius of less than four (4) times the cable diameter.
 - 5. Cabling installation shall meet all manufacturer's written instructions.

3.04 INSTALLATION FOR DIRECT CONNECTION TO USER EQUIPMENT (STATION END DEMARK)

- A. ***In-wall installations connecting to non-telecom equipment in rooms with hung ceilings and requiring a direct, permanent, inaccessible connection to the Ethernet shall be connected as follows: (See Fig. #167 in Appendix B)***
 - 1. ***All structured cable shall be terminated using an 8p8c modular jack (termination) in a standard faceplate, mounted in its own 4 11/16" square, 2 1/4" deep back box.***
 - 2. ***A "sheppard's hook", 1 1/4" conduit shall run from the back box to the area above the hung ceiling in the user's space.***
 - 3. ***A similar conduit and back box shall be installed at the location required by the end user.***
 - 4. ***In the ITS Telecomm back box (demark location), one (up to 4) jack(s) shall be "pushed back" into the back box and the empty "hole" created shall be filled with an appropriately colored "snap-in" blank.***
 - 5. ***An ITS Telecomm group technician (only) shall plug the user extension cable into the jack and run cable to the area above the hung ceiling. There the cable will be coiled and left for the end user.***
 - 6. ***The end user shall, using proper wire installation techniques as stated in the Cal Poly TSD, EIA/TIA and BICSI Standards, run the cable to the required locations and connect to their equipment.***
 - 7. ***The end user provided jumper cable connecting to their equipment shall be identified cable using the ITS Telecomm faceplate port designation and number (at minimum) for that cable. A 1" wide white (with black ink), nylon, machine generated label, incorporating the identical information at both ends, shall be attached. (See Fig. #107 & #167 in Appendix B)***

3.05 GROUNDING & BONDING

- A. N/A
- B. Refer to Section 27 05 26 for additional details.

3.06 TESTING

- A. For testing details see Section 27 08 13

3.07 ACCEPTANCE

- A. Upon receipt of the Contractor's test documentation, the Cal Poly ITS Telecomm group representatives shall review/observe the installation and may randomly request the testing of certain installed cables/wires. Once the installation, testing and review have been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative shall notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.08 RECORD (AS-BUILT) DRAWINGS

- B. The Project Record Drawings shall show the types and locations of all horizontal cabling. Drawings shall include identifying information from the cable identification labels.

END OF SECTION 27 15 14

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SECTION 27 15 23 - FIBER OPTIC STATION CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Optical fiber station cabling

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design & Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. Shop drawings shall show the locations where cables are to be routed and where terminating hardware is to be installed.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed/approved in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. The label shall be 1" white (permanent) polyester/nylon with black ink.
- B. Labels containing a unique cable ID designator shall be placed on both ends of all cables, 6 inches from the termination and/or patch panel.
- C. Subsequent to placing and terminating cables, the Contractor shall place all cable labels as noted above.
- D. If at any time during the job the cable tag becomes illegible or removed for whatever reason, the Contractor shall immediately replace it with a duplicate pre-printed cable label at the Contractor's expense.
- E. All cable labels shall be easily accessible, both physically and visually, upon completion of the job.
- F. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. CMP: Communications Plenum Cable
- B. CMR: Communications Riser Cable
- C. MPP: Multipurpose Plenum Cable
- D. OFNP: Optical Fiber Nonconductive Plenum Cable
- E. OFCP: Optical Fiber Conductive Plenum Cable
- F. LSZR: Low Smoke Zero Halogen Rated Cable
- G. OM1: Defined by ISO 11801 & TIA-492-AAAA, 62.5/125 μm multimode fiber. (old Campus Standard)
- H. OM2: Defined by ISO 11801 & TIA-492-AAAB, 50/125 μm multi-mode fiber.
- I. OM3: Defined by ISO 11801 & TIA-492-AAAC, laser-optimized 50/125 μm multi-mode fiber.
- J. OM4: Defined by TIA-492-AAAD, laser-optimized 50/125 μm multi-mode fiber (new Campus Standard)

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise.

2.02 FIBER OPTIC CABLES – GENERAL

- A. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1. Manufacturer's name and/or trademark
 - 2. Strand count
 - 3. Cable Type
 - 4. UL listing
 - 5. Sequential distance markings, in one-foot increments
- B. *All multimode shall be OM4, 50 μm multimode fiber.*
- C. *All single-mode shall be zero water peak single mode fiber.*

2.03 FIBER OPTIC STATION CABLE (2 STRAND SINGLEMODE)

- A. Cable should be plenum rated, tight buffered, 1.6mm zip-cord with strippable jacket and high tensile strength yarn layer.
- B. Jacket color shall be **yellow**.
- C. Approved Manufacturer: Commscope or Cal Poly ITS Telecomm group approved equal

2.04 FIBER OPTIC STATION CABLE – FLOOR OUTLET (2 STRAND SINGLEMODE)

- A. Non-Armored Jacket shall be plenum and OSP rated.
- B. Cable shall have aramid yarn and zip-cord immediately underneath jacket.
- C. Internal structure shall include water barrier layer and a central dielectric strength member.
- D. Jacket color shall be **black**.
- E. Approved Manufacturer: Commscope or Cal Poly ITS Telecomm group approved equal

PART 3 – EXECUTION

3.01 GENERAL

- A. Fiber optic station cables shall be used between the TR/ER and outlets serving user spaces or end user devices.
- B. Location, fiber count and placement detail for all fiber optic cables shall be as shown on the Drawings. C. Provide 20' slack loops at the TR end of all fiber optic cables.
- C. Provide 72" of stripped strands fiber wrapped neatly at each fiber cabinet.
- D. Provide 36" of stripped strands fiber wrapped neatly at each fiber outlet.
- E. Insure all fiber optic cables, as installed, are not subject to strain, and that correct bend radii are maintained at all times.
- F. Fiber optic station cables and copper cables may share conduit with approval of the Cal Poly ITS Telecomm group.
- G. Do not terminate fiber until after the rack locations and elevations of fiber cabinets have been reviewed and approved by the Cal Poly ITS Telecomm group representative.**

3.02 QUANTITIES

- A. Quantities of system elements shown on the Drawings are illustrative only and shall indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Optical Fiber Station Cables:
 - 1. Provide support for vertical runs of fiber optic riser cables.
 - 2. Route fiber optic cables over telecom ladder racking.
 - 3. Route fiber optic station cables together as a single bundle, not to be combined with copper or coax cabling.
 - 4. Installation of all fiber optic cables shall require the use of a breakaway swivel rated to the cable manufacturer's written specifications for pull strength.
 - 5. Follow all manufacturers' specifications for installation.
- B. Connector Installation
 - 1. Terminate both ends of each fiber cable with an appropriate fusion spliced factory terminated pigtail type connector. Fiber strands shall be terminated in strict compliance with the manufacturer's printed instructions.

2. ***Maximum length deferential between terminated strands shall be 1". If the length does not meet this requirement the cable shall be re-terminated.***
 3. Connectors for cables utilizing aramid yarn as a strength member shall integrate the yarn into the termination per manufacturer's written specifications.
 4. Connector type for single mode fiber shall be SC with LC connectors used for multimode cable.
 5. ***Fiber optic cable shall only be terminated using fusion splices with pig-tails. Field polished direct connections shall not be allowed.***
- C. Slack Loop
1. Slack loop at faceplate/outlet shall utilize integrated slack loop hardware.
 2. Slack loop in EF/TR/ER shall be mounted on the wall.
 3. ***Slack loop storage location shall be designated by the Cal Poly ITS Telecomm group representative.***

3.04 GROUNDING & BONDING

- A. None Required

3.05 TESTING

- A. Refer to Specification Section 27 08 23.

3.06 ACCEPTANCE

- A. 100% of the fiber tested shall meet requirements for the whole of the fiber installation to be accepted.
- B. Upon receipt of the Contractor's documentation of cable testing, the Cal Poly ITS telecomm group representative will review/observe the installation and randomly request tests of the cables installed. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the types and locations of all fiber optic cabling and fiber optic termination points. Drawings shall include identifying information as stated on the cable labels.

END OF SECTION 27 15 23

SECTION 27 15 43 - COMMUNICATIONS FACEPLATES AND MODULAR JACKS

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. Telecommunications faceplates and modular jacks.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.
- B. As noted in Section 27 00 00, all contractors and installers working on structured cabling system elements shall hold a current manufacturer's certification for each individual component they install.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standard in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. None Required
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets and approval by the Cal Poly ITS Telecomm group.

1.05 IDENTIFICATION

- A. All faceplates, outlets, and modular jacks shall be labeled per the Cal Poly I.T.S. Telecomm Labeling, Design & Syntax Standards in Appendix B. **(See Fig. #108 in Appendix B)**
- B. All faceplates that utilize windowed labeling inserts are to be machine generated on paper, and inserted behind the windows. See the Cal Poly I.T.S. Telecomm Labeling and Syntax Standards in Appendix B.
- C. Wall phone faceplates must be labeled. Use of preprinted self-adhesive labels is acceptable.
- D. Refer to Section 27 05 53 for general details.

1.06 DEFINITIONS

- A. Jack (Modular) – Termination points for telecommunications cabling that transitions from permanently installed station cable to a user end station wire (drop cable).

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise.

2.02 STANDARD WALL FACEPLATE

- A. Faceplates for single gang outlets shall have 4 (staggered) ports.
- B. All parts are to be white in color unless otherwise required to match electrical.
- C. Approved Manufacturer: AMP, Inc. or Cal Poly ITS Telecomm group approved equal.

2.03 BLANK INSERTS

- A. Approved Manufacturer: AMP, Inc. or Cal Poly ITS Telecomm group approved equal.

2.04 CAT 6 JACK

- A. Outlets must meet requirements for Category 6 of ANSI/TIA/EIA-568.
- B. Approved Manufacturer: AMP, Inc. or Cal Poly ITS Telecomm group approved equal.

2.05 WALL PHONE FACEPLATE W/ JACK

- A. Faceplates shall have a single 6P4C jack wired according to the TIA/EIA Standards.
- B. Attachment of conductors shall be via screw terminals.
- C. Faceplates shall be stainless steel with two studs for hanging a wall phone.
- D. Approved Manufacturer: Suttle or Cal Poly ITS Telecomm group approved equal.

2.06 FLOOR OUTLET BOX

- A. Floor boxes shall accommodate power and electrical with dedicated spaces and conduit entries.
- B. Cover shall be hinged, and have cable egress doors, and be able to fully close with all cable outlets in use.
- C. Approved Manufacturer: Legrand/Wiremold Evolution Series Floor Box (EFB) or Cal Poly ITS Telecomm group approved equal

PART 3 – EXECUTION

3.01 GENERAL

- A. Follow all manufacturers' written instructions.
- B. All category modular jacks shall be terminated using the T568A termination scheme specified in ANSI/TIS-568-C.0. (See Fig. #168 in Appendix B)**
- C. All faceplates, information outlets, jacks, etc. shall be installed in the correct orientation per Manufacturer's Instructions.

3.02 QUANTITIES

- A. Quantities of system elements shown on the Drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 INSTALLATION

- A. Faceplates shall be installed straight and plumb in all directions.
- B. Faceplates shall cover the entirety of the outlet box hole in the wall. If, due to overcutting or rough workmanship, the faceplate does not cover the entire hole, the wall shall be appropriately patched and painted for a neat and clean finished appearance.
- C. All unused positions in faceplates shall be filled with blanks.**
- D. All telecommunications outlets/faceplates, except for surface mount boxes, shall be installed over enclosed back boxes.
- E. All faceplates shall be fastened to back box with threaded machine screws of appropriate length.
- F. Faceplates shall be installed at appropriate ADA height.
- G. Faceplates shall match the trim color of accompanying electrical outlets.
- H. Wall faceplates shall be installed at the same height as accompanying electrical outlets, unless specific heights are noted on the Drawings, or it is so stated in the Specifications.
- I. Wall Phone Faceplate
 - 1. Refer to the ADA for requirements concerning wall mount telecommunications devices.
- J. Surface Mount Boxes
 - 1. Surface mount boxes shall only be used in new construction for outlets above the ceiling or in mechanical/electrical spaces.
 - 2. Surface mount boxes shall not to be used in user spaces.
 - 3. Surface mount boxes shall be permanently attached to the building's structure with screws.
 - 4. Surface mount boxes shall not be installed inside panels used for other services unless those panels are accessible by Cal Poly ITS Telecomm group personnel.
- K. Floor Boxes
 - 1. Floor boxes shall utilize specified hardware and not require use of any proprietary adapters.

3.04 GROUNDING & BONDING

- A. None Required

3.05 TESTING

- A. Modular Jacks shall be tested as an element of the Structured Cabling System.

3.06 ACCEPTANCE

- A. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative will notify the Contractor and/or Cal Poly Project Manager in writing or via email.

3.07 RECORD (AS-BUILT) DRAWINGS

- A. None Required

END OF SECTION 27 15 43

SECTION 27 20 10 - WIRELESS DATA COMMUNICATIONS SYSTEM (WIFI)

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools, and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:
 - 1. A complete and operable WIFI, Wireless Data Communications System.
- B. All install locations, product configurations, and/or graphics must be approved by the Product Manufacturer and the Cal Poly ITS Telecomm group.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27 00 00.
- B. UL/CSA 60950
- C. FCC Regulations 47CFR part 68
- D. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. All system designs and Drawings shall be provided by the Manufacturer. System specifications shall be provided by the Manufacturer and/or the Cal Poly ITS Telecomm group. All system designs and drawings shall be reviewed and approved by the Cal Poly ITS Telecomm group prior to purchasing material and/or start of installation.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Use only the approved campus standard products and Manufacturer for this system. Submit designs and cut sheets for all equipment and materials proposed for use in the system.
for approval by the Cal Poly ITS Telecomm group.
- D. Provide Manufacturer's Warranty statement.
- E. Provide all user/installation/programming/service manuals for all installed equipment.

1.05 IDENTIFICATION

- A. All cables, junction boxes, faceplates, Wireless Access Points (WAPs), patch bays and

other communications infrastructure shall be labeled per Cal Poly ITS Telecomm Labeling, Design and Syntax Standards in Appendix B.

- B. Refer to Section 27 05 53 for additional details.

1.06 DEFINITIONS

- A. WIFI System shall provide an enterprise level signal to all areas of the specified project. Connected loading requirements (number of users supported at the same time) shall be provided by the University.

1.07 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of WIFI system equipment shall not be permitted.

2.02 WIFI – WIRELESS DATA SYSTEM

A. GENERAL

1. Aruba Networks - No Alternate
2. The Contractor shall work with Aruba Networks and bring them to the project site for the purposes of evaluating the site and developing a system design that delivers to the University a site-wide enterprise level signal that supports the loading characteristics specified by the University.
3. The University shall purchase and have delivered to the Contractor, the Manufacturer specified active components for the Contractor to install.
4. All other construction materials necessary to create the complete specified system shall be the sole responsibility of the Contractor to purchase and install.
5. The wireless access point network design shall be approved by The Cal Poly ITS Telecomm group before any materials are purchased and/or any work begins.
6. The Wireless Access Point System Controller shall be from Aruba Networks and shall be located in a building designated by the Cal Poly ITS Telecomm group. Aruba Products shall be purchased by and provided to the installer by the University.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation at minimum shall be as specified by the manufacturer.
- B. Do not install wireless access point devices until after the installation locations and cable test results have been approved by the Cal Poly ITS Telecomm group.
- C. Contractor shall provide all conduits, cable, boxes and other passive materials to deliver a

fully functional system that is constructed within the bounds of all codes, restrictions and Specifications.

- D. Electrical circuits used to provide power to each wireless access point installation shall be full time Power-over-Ethernet (PoE) connections provided by the project via a University installed network switch.
- E. All wireless access points (WAPs) shall be installed according to the manufacturer's installation instructions.
- F. Wireless Access Point (WAP) controllers shall be provided/purchased with project funds but shall be installed and connected to the campus fiber backbone by the Cal Poly ITS Telecomm group. **Dual CAT 6 Structured Cables shall be provided by the Project/Contractor to each WAP location.**
- G. Post Project Cleanup
 - 1. Remove rubbish, debris, and waste materials and legally dispose of such at an off-campus site.
 - 2. Restore any landscape, concrete, asphalt or aesthetic elements disturbed during installation.

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 GROUNDING & BONDING

- A. N/A

3.04 TESTING

- A. Testing shall require a heat map proving proper functioning of all WAPs (before the system can be accepted/approved). A random evaluation or demonstration of certain WAPs (up to 10%) shall be provided at no additional cost by the Contractor at the request of and in the presence of a Cal Poly ITS Telecomm group representative.

3.05 ACCEPTANCE

- A. Upon receipt of the Contractor's testing documentation, the Cal Poly ITS Telecomm group representative will review/observe the installation and randomly request tests of the device as installed. Once the installation, testing and repairs (if necessary) have been completed and the final "heat map" has been received and approved by the Cal Poly ITS Telecomm group representative, the Cal Poly ITS Telecomm group representative will notify the Contractor and/or the Cal Poly Project Manager in writing or via email of approval.
- B. **All installation locations, product configurations, labeling and test data must be approved by Cal Poly ITS Telecomm group.**

3.06 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the type and location of each WAP device.

END OF SECTION 27 20 10

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SECTION 27 32 16 - WIRELESS TRANSCEIVERS (RADIO FREQUENCY (RF) COMMUNICATIONS OR CONTROL)

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The work covered by this section of the Specifications shall include all labor necessary to perform and complete such construction/installation, all materials and equipment incorporated or to be incorporated in such construction/installation and all services, facilities, tools and equipment necessary or used to perform and complete such construction/installation. The work of this section shall include, but is not limited to, the following:
 - 1. A complete and operable wireless, RF communications or control system.
- B. All installation locations, products, system configurations, permits, applications and/or licenses must be coordinated with, reviewed, and approved by the Cal Poly ITS Telecomm group.

1.02 QUALITY ASSURANCE

- A. Refer to Section 27 00 00 for general details.

1.03 CODES, STANDARDS, AND GUIDELINES

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 27-00-00.
- B. Cal Poly University Airwaves Policy - http://www.netadmin.calpoly.edu/documentation/airwave_policy.pdf
- C. Cal Poly University Two-Way Radio Frequency Coordination Standard – http://www.netadmin.calpoly.edu/documentation/Two_Way_Radio_Policy.pdf
- D. Information Technology Resources Responsible Use Policy– <http://security.calpoly.edu/policies/rup/>
- E. FCC Regulations – USC - Title 47 - part 90
- F. The Cal Poly ITS Telecomm group, Telecommunications Standards Document and the Labeling, Design and Syntax Standards in Appendix B.

1.04 SUBMITTALS

- A. Refer to Section 27 00 00 for general details.
- B. Shop Drawings:
 - 1. All system requirements shall be developed by the user. All system designs and specifications shall be developed by the user in coordination with and with the approval of the Cal Poly ITS Telecomm group. Product specifications shall be provided by the Manufacturer and approved by the Cal Poly ITS Telecomm group it is to be used on the Cal Poly Campus. All system designs and drawings shall be reviewed and approved by the Cal Poly ITS Telecomm group prior to the purchasing of equipment and/or the start of installation and/or demolition.
- C. Submit Manufacturer's Cut Sheets for the following:
 - 1. Submit designs and cut-sheets for all equipment and materials to be used in the system for approval by the Cal Poly ITS Telecomm group.

- D. Provide Manufacturer's Warranty statement.
- E. Provide all user/installation/programming/service manuals for all installed/purchased equipment.
- F. Acquire all necessary Cal Poly building permits, authorizations and approvals for all systems. A partial list of system types would include: Two-Way Radios, Radio Base Stations, RF System Controls, Cell Antenna Units (CAU), Distributed Antenna Systems (DAS), Cell Phone Boosters, and so on.

1.05 IDENTIFICATION

- A. All RF communications infrastructure and two-way radio equipment shall be FCC licensed as required under the guidance of the Cal Poly ITS Telecomm group.

1.06 DEFINITIONS

- A. The Two-Way Radio/Transceiver System shall provide an adequate signal level and connectivity to users and/or equipment in all areas within the specified project area. The number of users and types of equipment supported simultaneously shall be specified by the User.

1.07 WARRANTY

- A. Refer to Section 27-00-00 for general details.

PART 2 – PRODUCTS

2.01 PRODUCT CONSISTENCY

- A. Product Consistency: Any given item of equipment or material shall be the product of one manufacturer throughout the facility/project area. Multiple manufacturers of the same Transceiver/RF system equipment shall not be permitted.

2.02 WIRELESS TRANSCEIVER SYSTEM

- A. GENERAL
 - 1. The Contractor shall work with the User and the Cal Poly ITS Telecomm group. The Contractor shall bring them to the project site for the purposes of evaluating the site and developing a system design that delivers a site-wide signal level that supports the User specified loading, coverage and/or control characteristics.
 - 2. All equipment/materials shall be purchased by and/or delivered to the Contractor or the Cal Poly ITS Telecomm group, whichever group is most appropriate, for installation as specified in the contract documents.
 - 3. Approved Manufacturer: Kenwood (RF transceiver) or Cal Poly ITS group approved equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Do not install any transceiver devices until after their installation locations and any pre-installation test results have been reviewed and approved by the Cal Poly ITS Telecomm group.

- B. Contractor shall provide all conduits, cable, boxes and other passive materials to deliver a fully functional system that is constructed within the bounds of all codes, restrictions and specifications.
- C. All wireless transceivers shall be installed per manufacturer's installation instructions.
- D. Post Project Cleanup
 - 1. Remove rubbish, debris, and waste materials and legally dispose of such at an off-campus site.
 - 2. Restore any landscape, concrete, asphalt or aesthetic elements disturbed during installation.

3.02 QUANTITIES

- A. Quantities of system elements shown on the drawings shall be illustrative only and are meant to indicate the general configuration of the work. The Contractor shall be responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.03 GROUNDING & BONDING

- A. RF equipment/system installations performed under this section shall use the most appropriate and conservative of the following two Grounding Standards as determined by the Cal Poly ITS Telecomm group:
 - 1. National Electrical Code – 2011 Edition
 - 2. Motorola – R56 Grounding Standard – 2005 Edition

3.04 TESTING

- A. Testing shall require that the proposed system shall be deemed fully functioning as described in the scope/contract documents by the Cal Poly ITS Telecomm group.

3.05 ACCEPTANCE

- A. Upon receipt of notice of the Contractor's completion of the installation, the Cal Poly ITS Telecomm group representative will review/observe the installation and if desired, randomly request tests of the devices as installed. Once the installation and testing has been completed and the Cal Poly ITS Telecomm group representative is satisfied that all work is in accordance with the Contract Documents, the Cal Poly ITS Telecomm group representative will notify the Contractor and/or the Cal Poly Project Manager in writing or via email of their approval.
- B. *All installation locations, product configurations, labeling and testing must be approved by the Cal Poly ITS Telecomm group.***

3.06 RECORD (AS-BUILT) DRAWINGS

- A. The Project Record Drawings shall show the type and location of each Wireless Transceiver device.

END OF SECTION 27 32 16

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Division 28 - Electronic Safety and Security

28 01 00 - Operation and Maintenance of Electronic Safety and Security

Electronic Monitoring and Control:

Fire Alarm Testing:

Standard: Provide bypasses for testing signals, dampers, HVAC shutdowns, etc.

28 05 28 - Pathways for Electronic Safety and Security

Fire Alarm Cables:

Standard: Fire alarm sensor and network cables shall be in conduit.

Keys for Cabinets and Padlocks:

- Cabinets and Equipment: Provide 2 keys per panel. Coordinate with Section 08 06 05 – Key Schedule.
- Padlocks: Coordinate with Section 08 06 05 – Key Schedule.
- Closeout Submittal: Provide panel keys separated and labeled. Provide location, room number, quantity, manufacturer name and model numbers of keys, and coordinate closeout submittal with Section 08 06 05 – Key Schedule.

28 31 00 - Fire Detection and Alarm

Fire Alarm System: General:

Fire Alarm System: Manufactured by an ISO 9001 certified company and meet requirements of BS EN9001: ANSI/ASQC Q9001-1994.

In-place Campus Alarm Central Station System – Provide panel components and programming of panel to work within Campus system. The system requires telephone line communication, and communication formats in Ademco Contact ID, or Radionics Modem IIe.

Scope:

Basic Performance:

- Alarm, trouble and supervisory signals from all intelligent reporting devices: Encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
- Initiation Device Circuits (IDC): Wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.
- Notification Appliance Circuits (NAC): Wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
- On Style 6 or 7 (Class A) configurations on a single ground fault or open circuit on the system Signaling Line Circuit: Not cause system malfunction, loss of operating power, or the ability to report an alarm.
- Alarm signals arriving at the FACP: Not lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
- NAC speaker circuits: Arrange such that there is a minimum of one speaker circuit per floor of the building or smoke zone, whichever is greater.
- Audio amplifiers and tone generating equipment: Electrically supervised for normal and abnormal conditions.

- NAC speaker circuits and control equipment: Arrange such that loss of any 1 speaker circuit will not cause the loss of any other speaker circuit in the system.
- 2-way telephone communication circuits: Supervised for open and short circuit conditions.

Basic System Functional Operation: When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur.

- The system alarm LED on the system display shall flash.
- A local piezo electric signal in the control panel shall sound.
- A backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- Printing and history storage equipment shall log the information associated with each new fire alarm control panel condition, along with time and date of occurrence.
- All system output programs assigned via control-by-event interlock programming to be activated by the particular point in the alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

Submittals:

- Product data: Submit for each item, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.
- Shop Drawings: Submit with manufacturer's name(s), model numbers, ratings, power requirements; equipment layout, device arrangement, wiring point-to-point diagrams, and conduit layouts; annunciator layout, configurations and terminations; sections of typical trim members; and attachments to other work.
- Operating and Maintenance Manuals: Include manufacturer's name(s), technical data sheets; wiring diagrams indicating internal wiring for each device and interconnections between the items of equipment; clear, concise description of operation to properly operate the equipment and systems. Submit with shop drawings.
- Certifications for Installation Supervisor and Maintenance Personnel: From major equipment manufacturer certifying personnel are authorized representatives of the major equipment manufacturer. Include names and addresses in the certification. Submit with shop drawings.
- Comply with Section 01 33 00 – Submittal Procedures.

Post Contract Maintenance:

Provide complete maintenance and repair service for fire alarm systems from a factory trained, authorized representative of the major equipment manufacturer for a period of five (5) years after expiration of the guaranty.

Products:

Main Fire Alarm Control Panel or Network Node

Purpose: Communicate with and control intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices. Use 2-way telephone communication circuits, supervised for open and short circuit conditions.

Standard:

- Manufacturer: Notifier by Honeywell International Inc.
- Models: ONYX Series with voice notification capabilities

- Website: <http://www.notifier.com/products/controlpanels.htm>
- Note: Fire•Lite Alarms by Honeywell will be considered by Campus Facility Services on a case-by-case basis. No other substitutions allowed.

Operator Control:

- Acknowledge Switch: Upon activation in response to new alarms and/or troubles: Silence local panel piezo electric signal and change alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of switch shall advance LCD display to next alarm or trouble condition.
- Depression of switch: Silences remote annunciator piezo sounders.

Alarm Silence Switch: Upon activation: Programmed alarm notification appliances and relays shall return to normal condition after an alarm condition. Notification circuits and relay selection silenceable by switch shall be field programmable with confines of applicable standards. PACP software shall include silence inhibit and auto-silence timers.

Alarm Activate (Drill) Switch: Shall activate notification appliance circuits. Drill function shall latch until panel is silenced or reset.

System Reset Switch: Upon activation: Electronically latched initiating devices, appliances and software zones, plus associated output devices and circuits, shall return to normal condition.

Lamp Test: Upon activation: Local system LEDs shall activate, each segment of the liquid crystal display shall light, and panel software revision shall display.

Signal Bypass Switch for Alarm Testing:

- Horns and strobes shall remain silent.
- Dampers shall remain open.

System Capacity and General Operation:

Control Panel and Network Nodes:

- Provide or be capable of expansion to 636 intelligent / addressable devices.
- Include Form-C alarm, trouble, supervisory, and security relays rated at 2.0 amps @ 30 VDC, minimum.
- Include Four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.
- Support 8 additional output modules with 8 circuits each, minimum (64 circuits) for signal, speaker, telephone, or relay. Circuits shall be either Class A (NFPA Style Z), or Class B (NFPA Style Y).
{Note to Designer: Coordinate specifications and drawings.}
- Operator Interface Control and Annunciation Panel: Full featured with backlit Liquid Crystal Display (LCD), individual color coded system status LEDs and alphanumeric keypad with easy touch rubber keys for field programming and control of fire alarm system.
- Special Tools, PROM Programmers and PC Based Programmers: Not required to program, configure and expand system in the field.
- Memory ICs: Not required to be replaced to facilitate programming changes.
- Programming of System:

Technology Park Phase 2

Construction Documents

- Allow programming of an input to activate an output or group of outputs.
- Support 20 logic equations, minimum, including “and,” “or,” and “not,” or time delay equations for advanced programming.
- Logic equations shall require a PC with software utility design for programming.
- Not Allowed: Systems with limited programming (such as general alarm), complicated programming (such as a diode matrix), and requiring a laptop personal computer.
- Features:
- Drift compensation to extend detector accuracy of life, and include a smoothing feature allowing transient noise signals to be filtered out.
- Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
- Maintenance alert, with two levels (maintenance alert / maintenance urgent), to warn of excessive smoke detector dirt and dust accumulation.
- Nine sensitivity levels for alarm to be selected by detector. Alarm level range between 0.5 to 2.35 percent per foot for photoelectric detectors, and 0.5 to 2.5 percent per foot for ionization detectors. Support sensitive advanced detection laser detectors with an alarm level range of 0.03 percent per foot to 1.0 percent per foot. Include nine levels, minimum of Pre-alarm, selected by detector, to indicate impending alarms to maintenance personnel.
- Display or print system reports.
- Alarm verification, with counters and trouble indication to alert maintenance personnel with a detector enters verification 20 times.
- PAS pre-signal, meeting NFPA 72 3-8.3 requirements.
- Rapid manual station reporting (under 3 seconds).
- Meet NFPA 72 Chapter 1 requirements for activation of notification circuits within 10 seconds of initiating device activation.
- Periodic detector test, conducted automatically by software.
- Self-optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
- Cross zoning with the capability of counting two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
- Walk test with a check for two detectors set to same address.
- Control-by-time for non-fire operations, with holiday schedules.
- Day/night automatic adjustment of detector sensitivity.
- Device blink control for sleeping areas.
- Coding:
- FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2-2.2.2), and California Code.
- Panel notification circuits (NAC 1, 2, 3 and 4) shall support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two-stage operation shall allow 20 Pluses Per Minute (PPM) on alarm and 120 PPM after 5 minutes, or when a second device activates. (Canadian Dual Stage is the same as Two-Stage, except will only switch to second stage by activation of Drill Switch 3- or 5-minute timer.)
- Provide coding option to synchronize specific strobe lights designed to accept a specific “sync pulse.”
- Network Communication:
- Network Architecture: Local Area Network (LAN), a firmware package that utilizes a peer-to-peer, inherently regenerative communication format and protocol.

Protocol shall be based on ARCNET or equivalent. The network shall use a deterministic token-passing method.

Not acceptable: Collision detection and recovery type protocols; Master, polling computer, central file computer, display controller or other central element (weak link) in the network; cascading of CPUs or master-slave relationships at network level to facilitate network communications.

Nodes may be an intelligent Fire Alarm Control Panel (FACP), Network Control Station PC (NCS) or Network Control Annunciator (NCA).

Network shall be capable of expansion to 103 nodes, minimum.

Failure of a node shall not cause failure of communication degradation of other nodes or change the network communication protocol among surviving nodes located within distance limitations. Each node/panel shall communicate on the network at a baud rate of 312 KBPS (kilobits per second), minimum.

- Network node addresses shall be capable of storing Event equations. The event equations shall be used to activate outputs on one network node from inputs on other network nodes.
- Network shall be capable of communicating via wire or fiber optic medium. A wire network shall include a fail-safe means of isolating nodes in event of complete power loss to a node.
- Network Repeaters: A network repeater shall be available to increase twisted pair distance capability in 3000-foot increments, minimum. Optionally, a repeater shall be available for fiber optics to increase the wire distance in 10 dB increments, minimum. A mix (hybrid) fiber/wire network repeater shall also be supported.

Not acceptable: Systems with distance limitations, and no means to regenerate signals.

Fiber Optic Network Communication: Network shall support the following:

- Size: 62.5 micrometers / 125 micrometers.
- Type: Multimode, Dual Fiber, and Plenum Rated.
- Distance: 10 dB, maximum total attenuation between network nodes.
- Connector Type: ST.

Central Microprocessor:

- State-of-the-art, high speed, 16-bit RISC device capable of communicating with, monitoring and controlling external interfaces.
- Include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.

Capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs).

Systems that do not allow t-taps, or have restrictions (for example, in the amount of t-taps, length of t-taps, etc.) are not acceptable.

System Components

- Programmable Electronic Sounders

- Speakers
- Strobe lights meeting requirements of 2001 CBC and UL 1971, fully synchronized.
- Manual Fire Alarm Stations.
- Conventional Photoelectric Area Smoke Detectors.
- Conventional Ionization Type Area Smoke Detectors
- Duct Smoke Detectors.
- Projected Beam Detectors
- Automatic Conventional Heat Detectors
- Water Flow Indicator
- Sprinkler and Standpipe Valve Supervisory Switches
- Alphanumeric LCD Type Annunciator
- Portable Emergency Telephone Handset Jack
- Fixed Emergency Telephone Handset
- Universal Digital Alarm Communicator Transmitter (UDACT)
- Field Wiring Terminal Blocks.
- Printer
- Video Display Terminal (VDT)

Equipment and Material:

- New and manufacturer's current model.
- Materials, appliances, equipment and devices: Tested and listed by a nationally recognized approval agency for use as part of a protective signaling system, and meeting the National Fire Alarm Code.
- Fasteners and supports: Adequately sized to support the required load.

Conduit: Sized to provide 40 percent, maximum fill of interior cross sectional area.

Wire:

- Initiating Device Circuits and Signaling Line Circuits: New 18 AWG, minimum.
- Notification Appliance Circuits: 14 AWG, minimum.
- Meet local, state and national codes (e.g., NEC Article 760).
- Meet fire alarm system manufacturer recommendations.
- Listed and approved by a recognized testing agency for use with a protective signaling system.
- Wire and Cable not installed in conduit:
- Fire resistance rating suitable for the installation as per NFPA 70 (e.g., FPLR).
- Not be exposed (visible).

Wire for multiplex communication circuit (SLC):

- Twisted and unshielded, and support 12,500 feet, minimum.
- System designed to permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.

Field Wiring: Electrically supervised for open circuit and ground fault.

Terminal Boxes, Junction Boxes and Cabinets: UL listed for purpose and use.

Capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs).

Execution:

- Initiating Circuits: Arranged to serve like categories, such as manual, smoke, and water flow.
- Mixed Category Circuits: Not allowed.
- Exception: Signaling line circuits connected to intelligent reporting devices.

Fire Control Panel:

- Connect to separate dedicated branch circuit; 20 amperes, maximum.
- Label circuit at main power distribution panel as "FIRE ALARM."
- Primary wiring: 12 AWG.
- Ground panel.

END OF SECTION 28 00 00, DIVISION 28

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SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Clear and grub the site as shown on the Drawings and specified herein.
- B. Related Work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 31 20 00 Earth Moving.
 - 3. Geotechnical Investigation Report for the project.

1.2 QUALITY ASSURANCE

- A. A Geotechnical Engineer will be retained by the Owner to observe performance of work in connection with Site Clearing, Grading, Excavation and Fill, Utility Trenching, Subgrade and Roadbed preparation, and perform compaction tests.
- B. Re-adjust work performed that does not meet technical or design requirements, but make no deviation from the contract documents without specific and written approval from the Architect.
- C. 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.

1.3 PRODUCT HANDLING

- A. Comply with pertinent provisions of Division 1 of these Specifications for Product Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Provide materials not specifically described but required for proper completion of the work of this Section, as selected by the Contractor subject to the approval of the Architect.
- B. Herbicide – Provide a dry, free-flowing, dust-free chemical compound, soluble in water, capable of inhibiting growth of vegetation, and approved for use on this work by governmental agencies having jurisdiction and the Architect.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper execution of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PROTECTION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
- C. Protect existing utilities indicated or made known.
- D. Protect trees and shrubs, where indicated to remain, by providing a fence around the tree or shrub a sufficient distance away and of sufficient height so trees and shrubs will not be damaged in any way as part of this work.
- E. Protection of persons and property:
 - 1. Barricade open depressions and holes occurring as part of this work, and post warning lights on property adjacent to or within public access.
 - 2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
 - 3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by operations under this Section.
- F. Use means necessary to prevent dust from becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.
- G. Maintain access to the site at all times.

3.3 CLEARING

A. Clearing and Grubbing

1. Remove all surface rocks, debris, trash, tree stumps, roots, and other vegetation within the extent of construction as indicated by the drawings. Do not remove vegetation in other areas.
 2. Fell trees, dispose of the trees and other vegetation designated for removal, together with the downed timber, snags, brush, wood, rocks, weeds grass and rubbish. Contractor shall provide a qualified professional tree surgeon to trim individual trees designated to be left standing within the cleared areas of all dead branches and of all live branches to such heights and in such manner as are indicated on the drawings or approved by the Architect. All limbs, branches and roots damaged during construction, together with those required to be trimmed, shall be neatly cut next to the hole of the tree or main branch or root. Cuts more than 1" diameter thus made and any injury to the tree trunk or main branches shall be immediately painted with tree wound paint.
 3. Grub soils to a depth adequate to remove all deleterious material from the working area of the site.
 4. Do not leave any root greater than one inch in diameter and larger in the ground to a depth of at least 12" below the existing ground surface or subgrade or the new graded surface, whichever is lower except as specifically approved by the Engineer. Treat roots remaining in the soil with an herbicide approved by the Landscape Architect.
- B. Removal of Debris: Remove all debris from the site in a legal manner and leave the site in a neat and orderly condition subject to the approval of the Owner. Do not store or permit debris to accumulate on the job site.

3.4 DISPOSAL

A. General:

1. Remove brush, grass, roots, trash, and other material from clearing operations.
 2. Dispose of away from the site in a manner determined by the Owner.
 3. Do not store or permit debris to accumulate on the job site.
- B. Do not burn debris at the site.

3.5 DUST CONTROL

- A. At the contractor's expense, use chemical palliative or spread water as required to maintain strict control of dust generated by operation of work under this Section.

3.6 CLEAN-UP

- A. Maintain cleanliness on roadways and other public area used by equipment. Contractor will be held responsible for immediate removal of all spillage on these pavings. Remove from the Project Site all rubbish, rubble, and debris found thereon and all materials and debris resulting from demolition, leaving site in a safe and clean condition.

END OF SECTION 31 10 00

SECTION 31 20 00 – EARTH MOVING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes, but is not necessarily limited to, work necessary or incidental to clearing and grubbing, excavating, grading, filling, and backfilling as shown, described, or reasonably inferred by contract documents.
- B. Geotechnical Investigation Report:
 - 1. A Geotechnical Investigation Report for the site of this work has been prepared. The Geotechnical Investigation Report may be inspected at the office of the Architect, and copies may be obtained at the cost of reproduction and handling upon request addressed to the Architect and accompanied by full payment.
 - 2. The recommendations of the Geotechnical Investigation Report are considered a part of the construction documents unless otherwise directed by the Architect.
- C. Use of Data:
 - 1. Reports were obtained only for the Architect's use in design, and are not a part of the contract documents except as noted.
 - 2. Reports are available for bidders' information, but are not a warranty of subsurface conditions.
 - 3. Bidders should visit the site and acquaint themselves with existing conditions.
 - 4. Prior to bidding, bidders may make their own subsurface investigations to satisfy themselves as to site and subsurface conditions, but such investigations shall be performed only under time schedules and arrangements approved in advance by the Architect.
 - 5. The grading recommendations portion of the report have been incorporated into these specifications and are a part of the contract documents.
- D. Related Work:
 - 1. Section 31 20 10 Grading.
 - 2. Section 33 00 10 Trenching, Backfilling and Compacting.
 - 3. Section 32 12 14 Subgrade and Roadbed.
 - 4. The Geotechnical Investigation Report prepared for this project.

1.2 PROJECT / SITE CONDITIONS

- A. General
 - 1. Use all means necessary to control dust on or near the site resulting from the performance of the work. Thoroughly moisten all surfaces to prevent dust being a nuisance to the public, adjacent uses, and concurrent work on site.

2. Contractor shall verify existing grades and dimensions before starting any grading operations. If any discrepancy exists, the Engineer shall be notified immediately.
3. Use all means necessary to protect all existing features, products, or items designated to remain, as well as all work of this Section. In the event of damage, repair or replace immediately to the approval of and at no additional cost to the Owner.
4. Protect trees and shrubs, where indicated to remain, by providing a fence around the tree or shrub a sufficient distance away to protect feeder root system and of sufficient height so trees and shrubs will not be damaged in any way as part of this work.
5. All existing benchmarks shall be protected and maintained throughout the course of the work. Monuments or stakes disturbed or destroyed during the course of the work shall be re-established without expense to the Owner.
6. Work shall be conducted as to avoid injury to persons and damage to adjacent property. This includes, but is not necessarily limited to:
 - a) Provide appropriate shoring, bracing, and barriers
 - b) Barricade open depressions and holes occurring as part of this work, and post warning lights on property adjacent to or within public access.
 - c) Operate warning lights during hours from dusk to dawn each day and as otherwise required.
 - d) Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining washout and other hazards created by operations under this Section.
7. An effort has been made to define the location of underground facilities within the job site. However, all existing utilities and other underground structures may not be shown on the drawings and their location where shown is approximate. Contractor shall assume sole and complete responsibility for locating all underground utilities and related facilities and for protection of same during the course of the construction. Contact Underground Service Alert U.S.A. of Southern California (800) 642-2444 two working days prior to the start of construction for assistance from the respective utilities. All utilities not a member of U.S.A. must also be notified.
8. Any hauling permits required by the local jurisdiction must be obtained and paid for under this contract. Off-site, all local codes and ordinances must be followed.
9. Maintain access to the site at all times.
10. Erosion control: Erosion control devices, as specified in the Erosion Control plan, shall be in place and in good condition at all times during construction of the project.

11. The contractor is responsible for the cost and acquisition of any necessary storm water permits through the Regional Water Quality Control Board and installation and compliance with the permit.

1.3 PROTECTION AND SAFETY

A. General:

1. Perform all work in accordance with all current regulations, including safety requirements of the California Administrative Code, Title 8, and California Labor Code, Div. 5, Part 3.
2. Comply with all current regulations of the Federal Occupational Safety and Health Act (OSHA).

1.4 QUALITY ASSURANCE

A. General: Equipment and methods used shall be subject to the Geotechnical Engineer's inspection, test and approval.

B. Samples: Samples of all materials used shall be supplied and submitted for the Geotechnical Engineer's approval wherever specified or as directed by the Soils Report.

C. Testing:

1. The Owner will retain and pay a qualified Geotechnical Engineer to observe performance of work in connection with Site Clearing, Excavation and Fill, Utility Trenching, Subgrade and Roadbed preparation and to perform compaction tests. The Geotechnical Engineer shall take all field samples and do all laboratory testing necessary to insure compliance of the work to these Specifications or as required by Architect or other regulatory agencies. The Geotechnical engineer shall submit results of all testing done during the course of the work to the Owner, Engineer, and Contractor.
2. Notify testing lab a minimum of 48 hours in advance of testing required to satisfy requirements of this section.
3. Should testing specified above show work which does not satisfy these Specifications, the Contractor shall pay, through the Owner, for all additional tests required to determine the extent of work that is not satisfactory and for all additional tests necessary to demonstrate compliance with these specifications.

D. Certification Upon Completion of the Work: Contractor shall certify in writing to the Owner and the Engineer that all earthwork was performed in accordance with this specification and as shown on drawings.

1.5 REFERENCES

A. General

1. In addition to complying with all current, applicable codes and regulations, including Chapter 18 of the 2019 California Building Code, Title 24, Part 2, comply with applicable sections of:
 - a. The geotechnical recommendation of the Geotechnical Investigation Report for this project.
2. All of the above specifications shall be consulted. The most restrictive specification shall apply.

PART 2 - PRODUCTS

2.1 FILL MATERIAL FOR SUB-GRADE PREPARATION

- A. Refer to Section 33 00 10 Trenching, Backfilling, and Compacting.
- B. Refer to Section 32 12 14 Subgrade and Roadbed.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. Inspection of site: The Contractor shall prior to the bid, visit the site and determine for himself the existing conditions, nature of materials to be encountered and all other facts concerning or affecting the work to be done under the Section.
- B. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper elimination of the work. Do not proceed until unsatisfactory conditions are corrected.
- C. Contractor shall verify, in field, all elevations, flow lines, points of connections. Any discrepancies shall be called to the Architect's attention before proceeding with the work.

3.2 SITE CLEARING

- A. Refer to Section 31 10 00 Site Clearing.

END OF SECTION 31 20 00

SECTION 31 20 10 - GRADING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes, but is not necessarily limited to compaction and grading the site to the elevations shown on the Drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.
- B. Related Work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 31 20 00 Earth Moving
 - 3. Geotechnical Investigation Report and Geotechnical Engineer

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen 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.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- C. In addition to complying with requirements of governmental agencies having jurisdiction, comply with the directions of the soils engineer
- D. The standard tests used to determine maximum dry density and field density shall be ASTM D1557-07 and ASTM D6938-07b respectively.

1.3 PRODUCT HANDLING

- A. Comply with pertinent provisions of Section 01 60 00

PART 2 - PRODUCTS

2.1 TOPSOIL

- A. Where and if shown on the Drawings or otherwise required, provide topsoil consisting of friable, fertile soil of loamy character, containing an amount of organic

- matter normal to the region, capable of sustaining healthy plant life, and reasonably free from subsoils, roots, heavy or stiff clay, stones larger than 2" in greatest dimension, noxious weeds, sticks, brush, litter, and other deleterious matter.
- B. Obtain topsoil from sources within the project limits, or provide imported topsoil obtained from sources outside the project limits, or from both sources.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINISH ELEVATIONS AND LINES

- A. Comply with pertinent provisions of Section 32 00 10 Field Engineering.

3.3 PROCEDURES

- A. Utilities:
1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.
 2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
 3. If service is interrupted as a result of Work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
 4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Architect and secure his instructions.
 5. Do not proceed with permanent relocation of utilities until written instructions are received from the Architect.
- B. Protection of Persons and Property:
1. Barricade open holes and depressions occurring as part of this Work, and post warning lights on property adjacent to or with public access.
 2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.
- C. Dewatering:
 1. Remove all water, including rain water, encountered during trench and substructure work to an approved location by pumps, drains, and other approved methods.
 2. Keep excavations and site construction area free from water.
 3. Notify the Qualified SWPPP Developer/Practitioner 24 hours prior to any dewatering.
- D. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.
- E. Maintain access to adjacent areas at all times.

3.4 COMPACTING

- A. Control soil compaction during construction to provide the minimum percentage of maximum dry density and field density specified for each area as determined according to ASTM D1557-07 and ASTM D6938-07b respectively.
- B. Provide not less than the following maximum density of soil material compacted at optimum moisture content for the actual density of each layer of soil material in place, and as approved by the soils engineer.
 1. Structures:
 - a) All compact soils beneath the proposed new building section shall be compacted to a minimum 95% of maximum density.
 2. Lawn and Unpaved Areas:
 - a) Compact the top 8" of subgrade and each layer of fill material or backfill material at 90% of maximum density;
 3. Walks:
 - a) Compact the top 8" of subgrade and each layer of fill material or backfill material at 95% of maximum density.
 4. Pavements:
 - a) Compact the top 12" of subgrade and each layer of fill material or backfill material at 95% of maximum density for cohesive soil material.
- C. Moisture Conditioning and Control:
 1. "Moisture conditioning" refers to the moistening or drying of soils to at least optimum moisture content, prior to application of compactive effort.
 2. Where subgrade or layer of soil material must be moisture-conditioned before compacting, uniformly apply water to surface of subgrade or layer of soil material to prevent free water appearing on surface during or subsequent to compacting operations.

3. Remove and replace, or scarify and air dry, soil material that is too wet to permit compacting to the specified density.
4. Soil material that has been removed because it is too wet to permit compacting may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value as determined by moisture-density relation tests approved by the Geotechnical Engineer.

3.5 DRAINAGE CONTROLS

- A. Provide all necessary temporary apparatus, pumps, curbs, or ditches as required to divert or convey water from any source away from the work. Do not allow water from any source to accumulate within or damage earthwork. Notify the Qualified SWPPP Developer/Practitioner 24 hours prior to any dewatering.

3.6 FINISH SITE GRADING/PROTECTION

- A. General
 1. Grade all surfaces on the site where indicated and within the construction areas to elevations indicated and as required to insure proper drainage and disposal of surface water. Shape grades to drain away from buildings at minimum 2% slope, as shown on drawings, or as directed by the Geotechnical Engineer.
 2. After grading is completed, and the Geotechnical Engineer has finished his observation of the work, no further excavation or filling shall be done except with the review of, and under the observation of, the Geotechnical Engineer.
 3. It shall be the responsibility of the Contractor to prevent erosion of the freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.7 TOLERANCES

- A. Earthwork
 1. All rough grading shall be placed to a vertical tolerance of plus or minus one tenth (.1) foot.
 2. All rough grading shall be placed to a horizontal tolerance of plus or minus one half (.5) foot.

3.8 FIELD QUALITY CONTROL

- A. Secure the Geotechnical Engineer's inspection and approval of subgrades and fill layers before subsequent construction is permitted thereon.

- B. Provide at least the following tests to the approval of the soils engineer:
 - 1. At paved areas, at least one field density test for every 2000 sq ft of paved area, but not less than three tests;
 - 2. In each compacted fill layer, one field density test for every 2000 sq ft of overlaying paved area, but not less than three tests.
- C. If, in the Geotechnical Engineer's opinion based on reports of the testing laboratory, subgrade or fills which have been placed are below specified density, provide additional compacting and testing under the provisions of Section 01 40 00 of these Specifications.

3.9 MAINTENANCE

- A. Protection of Newly Graded Areas:
 - 1. Protect newly graded areas from traffic and erosion, and keep free from trash and weeds;
 - 2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.
- B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

3.10 CERTIFICATION

- A. Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to the Architect a written report from the soils engineer certifying that the compaction requirements have been obtained. State in the report the area of the fill or embankment, the compaction density obtained, and the type or classification of fill material placed.

END OF SECTION 31 20 10

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SECTION 32 00 10 – FIELD ENGINEERING

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Work included: Provide such field engineering services as are required for proper completion of the Work including, but not necessarily limited to:
 - 1. Establishing and maintaining lines and levels;
 - 2. Structural design of shores, forms, and similar items provided by the Contractor as part of his means and methods of construction.
- B. Related work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division I of these Specifications.
 - 2. Additional requirements for field engineering also may be described in other Sections of these Specifications.
 - 3. As described in The General Conditions, the Owner will furnish survey describing the physical characteristics, legal limitations, utility locations, and legal description of the site.

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen 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.

1.3 SUBMITTALS

- A. Comply with pertinent provisions of Division 1.
- B. Upon request of the Architect, submit:
 - 1. Data demonstrating qualifications of persons proposed to be engaged for field engineering services.
 - 2. Documentation verifying accuracy of field engineering work.
 - 3. Certification, signed by the Contractor's retained field engineer, certifying that elevations and locations of improvements are in conformance or nonconformance with requirements of the Contract Documents.

1.4 PROCEDURES

- A. In addition to procedures directed by the Contractor for proper performance of the Contractor's responsibilities:
1. Locate and protect control points before starting work on the site.
 2. Preserve permanent reference points during progress of the Work.
 3. Do not change or relocate reference points or items of the Work without specific approval from the Architect.
 4. Promptly advise the Architect when a reference point is lost or destroyed, or requires relocation because of other changes in the Work.
 - a) Upon direction of the Architect, require the field engineer to replace reference stakes or markers.
 - b) Locate such replacements according to the original survey control.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION 32 00 10

SECTION 32 01 90 - LANDSCAPE MAINTENANCE

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Work Specified in this Section: Furnish all labor, material, equipment, and services required to maintain the landscape in an attractive condition as specified herein for a period of 90 calendar days.
- B. Definition: The word Architect as used herein shall refer to the Landscape Architect or the Owner's authorized representative.

1.2 QUALITY ASSURANCE

- A. The Contractor's representatives and employees shall be experienced in landscape maintenance.

1.3 90 CALENDAR DAY MAINTENANCE PERIOD

- A. The Contractor shall continuously maintain all areas involved in this Contract during the progress of work. Maintenance period shall not start until all elements of construction, planting, and irrigation for the entire project are in accordance with Plans and specifications.
 - 1. A prime requirement is that all lawn and groundcover areas shall have been planted and that all lawn areas shall show an even, healthy stand of grass seedlings or sod, either of which shall have been mowed twice. Maintenance period will not be shortened when this criteria is met, but may be lengthened if not met.
 - 2. The Contractor's maintenance period will be extended if the provisions required within the Plans and specifications are not fulfilled. Project may not be segmented into maintenance phases.
 - 3. The Contractor shall request a Pre-Maintenance inspection by the Owner and Architect at the completion of the installation process.
 - 4. The Maintenance Period shall begin upon successful completion of the Pre-Maintenance walk-through punch list and acceptance of the landscape installation by the Owner.
 - 5. If such criteria are met to the satisfaction of the Owner, a field notification will be issued to the Contractor to establish the effective beginning date of the maintenance period.
- B. The Maintenance Period continues for 90 calendar days until final acceptance of the work by the Owner. Improper maintenance or poor condition of planting at the

termination of the scheduled maintenance period may cause postponement of the final completion date of the Contract.

- C. Any day when the Contractor fails to adequately maintain planting, replace unsuitable plants or do weed control or other work, as determined necessary by the Owner, will not be credited as one of the maintenance period working days.

1.4 GUARANTEE AND REPLACEMENT

- A. Guarantee: All plant material installed under the contract shall be guaranteed for a period of one year. Plants found to be dead or in poor condition due to faulty materials or workmanship, as determined solely by the Architect, shall be replaced by the Contractor at his expense.
 - 1. Replacement: Materials found to be dead, missing, or in poor condition during the Maintenance period shall be replaced immediately.
 - 2. The Architect shall be the sole judge as to the condition of material.
 - 3. The Contractor shall replace material rejected during the Guarantee period within fifteen (15) days of written notification by the Owner.

1.5 OBSERVATION VISITS

- A. The Contractor shall request progress visits from the Architect at least 48 hours in advance of anticipated visits. Normal observation visits are as follows:
 - 1. Immediately prior to the commencement of the work in this section.
 - 2. Completion of first 90 days of maintenance.
 - 3. Final acceptance.

1.6 FINAL ACCEPTANCE OF THE PROJECT

- A. Prior to the date of the final observation visit, the Contractor shall acquire from the Architect-approved reproducible Plans and record (from the job record set) all changes made during construction, label these Plans "Record Drawings", and deliver to the Architect for review and approval.
- B. Prior to the date of final inspection, the Contractor shall deliver to the Architect a written "Landscape and Irrigation Guarantee" as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials used shall either conform to landscape specifications in other sections or shall otherwise be acceptable to the Owner.

- B. The Owner shall be given a monthly record of all herbicides, insecticides, and disease control chemicals used. Failure to provide such a record will continue maintenance period until compliance occurs.

PART 3 - EXECUTION

3.1 MAINTENANCE

- A. Maintenance shall be performed according to the following standards:
 - 1. All areas shall be weeded and cultivated at intervals of not more than ten (10) days.
 - 2. Watering, mowing, rolling, edging, trimming, fertilization, spraying, and pest and rodent control, as may be required, shall be included in the maintenance period.
 - 3. Street gutters shall be cleaned as part of the maintenance program.
 - 4. The Contractor shall be responsible for maintaining adequate protection of the area.
 - a. Damaged areas shall be repaired at the Contractor's expense.
 - 5. Between the 15th day and the 20th day of the maintenance period, the Contractor shall reseed and re-sod all spots or areas within the lawn where normal turf growth is not evident.
- B. The Contractor shall be responsible for reporting to the Owner conditions beyond his control that prevent or have negative impact on the work required herein.

3.2 TREE AND SHRUB CARE

- A. Watering
 - 1. Apply enough irrigation water so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth.
 - a. Do not maintain soils in a constantly wet condition.
 - b. Contractor shall be responsible for familiarizing himself with the particular water requirements for the various plantings and shall be responsible for setting and maintaining the automatic controller to optimum minimum levels.
 - c. Damage to the plantings caused by over-watering or under-watering shall be the responsibility of the Contractor to replace at no cost to Owner.
 - 2. Maintain a water basin around newly planted plants so that water can be applied to moisturize throughout the root zone. At the end of the maintenance period these basins shall be flattened out to match surrounding grades.
 - 3. If hand-watering, use a fan spray nozzle to break the water force.
- B. Tree Pruning

1. Nursery grown trees will not normally require pruning for the first year. Prune trees only if directed by Architect or Owner, and only for these purposes:
 - a. selection and development of permanent scaffold branches that have a vertical spacing of from 18" to 48" and radial orientation so as not to cross each other,
 - b. elimination of diseased or damaged growth,
 - c. elimination of narrow V-shaped branch forks that lack strength,
 - d. reduction of toppling and wind damage by thinning out crowns,
 - e. maintenance of growth within space limitations,
 - f. maintenance of natural appearance,
 - g. Balancing of crown-to-root ratio.
 2. Under no circumstances will stripping of lower branches ("rising up") of young trees be permitted.
 - a. Lower branches shall be retained in a "tipped-back" or pinched condition with as much foliage as possible to promote caliper trunk growth (tapered trunk).
 - b. Lower branches can be cut flush with trunk only after the tree is able to stand erect without staking or other support.
 3. Evergreen trees shall be thinned out and shaped when necessary to prevent wind and storm damage. The primary pruning of deciduous trees shall be done during the dormant season. Damaged trees or those that constitute health or safety hazards shall be pruned at any time of the year as required.
- C. Shrub Pruning
1. The objectives of shrub pruning are the same as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the design.
 2. All pruning cuts shall be made to lateral branches or buds or flush with the trunk. "Stubbing" will not be permitted.
- D. Staking and Guying: Stakes and guys shall remain in place until final acceptance and are to be continuously inspected and adjusted to prevent girdling of trunks or branches and to prevent rubbing that causes bark wounds and to allow trees to sway freely. Stakes and guys are to be removed when trees become sufficiently well rooted or after one year. When stakes or guys are removed, tree heads may be thinned to reduce wind load.
- E. Weed Control: Keep all areas, including basins and areas between plants, free of weeds.
1. Use recommended legally approved herbicides only when mechanical removal methods are not feasible.
 2. Avoid frequent soil cultivation next to trees or shrubs that destroys shallow roots.
 3. Use mulches to help prevent weed seed germination.

Pest and Disease Control: Maintain control of insect and rodent infestations. The preferred method of control shall be biological control, or with non-toxic, biodegradable, organic materials. If stronger materials are needed, only materials that are recommended by a licensed Pest Control Advisor and are EPA approved and regulated shall be used. Only registered and licensed Pest Control Operators shall apply insecticide or chemical applications. Notify Owner a minimum of five (5) working days before chemical applications.

F. Fertilization

1. Fertilize all planting areas at 30-day intervals, with fertilizer and at rate as recommended by Soils Report.
 - a. Avoid applying fertilizer to root balls and bases of main stems
 - b. Spread fertilizer evenly around plants to drip line.
 - c. Distribute fertilizer evenly over turf or groundcover areas to avoid patchy coloration.

G. Replacement of Plants: Replace dead, dying, and missing plants with plants of a size, condition, and variety acceptable to Architect or Owner at Contractor's expense.

3.3 GROUND COVER CARE

- A. Weed Control: Control weeds preferably with mechanical methods, and also with preemergent herbicides and selective systemic herbicides. Hoe weeds as little as possible since this may result in plant damage. Foot traffic in planted areas shall be minimized, and soil compaction shall be loosened immediately.
- B. Watering: Water enough so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth.
 1. Do not maintain soils in a constantly wet condition.
 2. Contractor shall familiarize himself with the particular water requirements for the planting and shall be responsible for setting and maintaining the automatic controller to optimum minimum levels.
 3. Damage to the planting caused by over-watering or under-watering shall be the responsibility of the Contractor to replace.
- C. Trash: Remove trash weekly. Remove debris, clippings or branches produced by maintenance activities within 8 hours.
- D. Edging and Trimming: Edge ground cover to keep in bounds and trim top growth as necessary to achieve an overall even appearance.
- E. Replacement: Replace dead and missing plants at Contractor's expense.

3.4 IRRIGATION SYSTEM

- A. System Inspection: Contractor shall continuously check all systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each of the lateral. All heads are to be continuously adjusted as necessary for proper coverage and to eliminate over-spray on buildings or paving. Contractor's regular maintenance personnel shall test, observe, and adjust each sprinkler system no less than once per month.
- B. Controllers: Set and program automatic controllers for seasonal water requirements and minimum optimum water use. Give Owner's representative a key to controllers and instructions on how to turn off system in case of emergency.
- C. Repairs: Repair all damage to irrigation system at Contractor's expense. Repairs shall be made within one watering period.

END OF SECTION 32 01 90

SECTION 32 12 14 - SUBGRADE AND ROADBED

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes, but is not necessarily limited to the work necessary for the preparation of the subgrade.
 - 1. The subgrade will be considered as those areas and surfaces of new or existing streets, alleys, driveways, parking lots, sidewalks, or other places upon which additional materials are to be placed under Contract, or which are to be constructed or prepared for the future placement thereupon of other materials in accordance with Section 31 20 00 – EARTH MOVING, and as provided herein.

1.2 RELATED WORK DESCRIBED ELSEWHERE

- A. All underground work contemplated in the area of the subgrade shall be completed and properly backfilled before subgrade work is started. This is intended to include work on the Contract, work to be performed by the School District, or by others.
- B. These Specifications are to be used in conjunction with requirements in those sections of the Specifications having to do with specific types of base materials and pavements.
 - 1. Section 31 10 00 Site Clearing
 - 2. Section 31 20 00 Earth Moving
 - 3. Section 32 12 15 Aggregate Base
 - 4. Section 32 12 16 Asphalt Paving
 - 5. Section 32 13 13 Concrete Paving

PART 2 - PRODUCTS

2.1 EXCAVATION AND EMBANKMENT

- A. The excavation shall include removal of materials which are encountered in excavating to the required grades, including existing pavement and curbs designated to be removed, or as required to accomplish the construction.

2.2 EQUIPMENT

- A. Furnish all necessary equipment required to accomplish the excavating, shaping, grading and rolling, and compaction specified herein.

PART 3 - EXECUTION

3.1 SUBGRADE

- A. Excavate and shape subgrade to line, grade, and cross section. Roll subgrade with an approved roller until the top 12 inches is compacted to 95 percent of maximum density at optimum moisture content as determined by ASTM D 1557. Remove all soft or otherwise unsuitable material disclosed by the rolling and replace with suitable material from the excavation. Fill holes, and depressions which develop under the roller, to the required grade and cross sections with material from the excavation. The finished subgrade shall be within a tolerance of plus or minus 0.10 of a foot of the grade and cross section shown, shall be smooth and free from irregularities and at the specified density. Compaction shall extend one foot beyond the edge of paving, curb, or form work.
- B. The Contractor shall be responsible for the protection of existing improvements; any damage resulting from his operations shall be the Contractor's sole responsibility.

3.2 EXCAVATION BELOW GRADE

- A. Where the Geotechnical Engineer deems subgrade material to be unsatisfactory, excavation below grade will be required to such depths as necessary to remove the unsatisfactory material. Excavation below grade shall be of the same classification as that above it provided it is removed in the same operation as the normal excavation. Where the Contractor has completed the excavation and is required to remove additional, unsuitable material beyond the scope provided in these specifications, or where the additional depth requires special equipment because of unforeseen conditions, the work shall be performed and a payment for excavation below grade will be made on the basis of extra work as provided in the Contract.
- B. If the excavation below grade is required because of negligence on the part of the Contractor, the necessary excavation below grade and the backfilling required to restore the surface satisfactorily shall be at the Contractor's sole expense.
- C. The subgrade shall be sprinkled with water as required, and in such quantities as necessary, to obtain the specified compaction.

3.3 PROTECTION OF SUBGRADE

- A. After preparing the subgrade as above specified, all unnecessary traffic shall be kept off. Should it be found necessary to haul over the prepared subgrade, the Contractor shall drag and roll the traveled way as frequently as may be necessary to remove ruts, cuts, and breaks in the surface. All cuts, ruts, and breaks in the surface of the subgrade that are not removed by the above operations shall be raked and hand-tamped. All

equipment used for transporting materials over the prepared subgrade shall be equipped with pneumatic tires.

- B. Continued use of sections of prepared subgrade for hauling, so as to cut up or deform it from the true cross section, will not be permitted. The Contractor shall protect the prepared subgrade from both construction and public traffic.
- C. The subgrade shall be maintained in the finished condition until the first succeeding course is placed.

3.4 DRIVEWAYS

- A. Excavate and shape driveways to the lines, grades, and cross sections shown, or as determined in the field by the Engineer.

END OF SECTION 32 12 14

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SECTION 32 12 15 - AGGREGATE BASE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: This section covers the materials and work necessary for construction of aggregate base, as specified, complete.
- B. Related Sections:
 - 1. See Division 1 – General Requirements, which contain information and the requirements that apply to the work specified herein.
 - 2. Section 32 12 14 Subgrade and Roadbed.
 - 3. Section 32 12 16 Asphalt Paving
 - 4. Section 32 13 13 Concrete Paving
 - 5. The Geotechnical Investigation Report and the Geotechnical Engineer.

1.2 SUBMITTALS

- A. Samples and Testing: At least thirty (30) days prior to the use thereof, the Contractor shall submit to the Geotechnical Engineer a sample of aggregate, graded as intended for use. Provide sample size as directed by the Geotechnical Engineer, not to exceed 120 lbs. This requirement shall be complied with for each aggregate and grading thereof that has not been reviewed. The Geotechnical Engineer will test the sample at no cost to the Contractor, and will determine the acceptability of the aggregate.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aggregate: The aggregate shall be free from vegetative matter and other deleterious substances. Aggregate for aggregate base shall consist of material of which at least 60 percent by weight shall be crushed particles as determined by Test Method No. Calif. 205.
 - 1. The percentage composition by weight of aggregate base shall conform to one of the following gradings when determined by Test Method No. Calif. 202.

2. The particle size distribution shall be in accordance with the grading specified for 3/4-inch maximum size aggregate.

Percentage Passing

<u>Sieve Size</u>	<u>1-1/2"</u> <u>Maximum</u>	<u>3/4"</u> <u>Maximum</u>
2-Inch	100	
1-1/2-Inch	90-100	
1-Inch		100
3/4-Inch	50-85	90-100
No. 4	25-45	35-60
No. 30	10-25	10-30
No. 200	2-9	2-9

3. The aggregate base shall also conform to the following quality requirements:

<u>Tests</u>	<u>Test Method</u>		
	<u>No. Calif.</u>	<u>Requirements</u>	
Resistance (R-Value)*	301	78	Minimum
Sand Equivalent	217	22	Minimum
Durability Index	229	35	Minimum

4. The aggregate shall not be treated with lime, cement, or other chemicals before the Durability Index test is performed.
5. Material yielding a maximum dry density of less than 112 pounds per cubic foot when tested in the laboratory in accordance with ASTM "Standard Methods of Test of Moisture-Density Relations of Soils, Using 10-Pound Rammer and 18-Inch Drop", Designation D 1557, shall not be used.
6. Any rock, including red rock, meeting all the requirements of this Section will be acceptable. Such rock shall be plant processed at an approved processing plant.

2.2 EQUIPMENT

- A. Furnish all necessary equipment required to accomplish the spreading, shaping, and compaction required.

PART 3 - EXECUTION

3.1 SUBGRADE

- A. Proof roll subgrade immediately prior to commencement of spreading of aggregate base. Make necessary repairs as directed by the Geotechnical Engineer OR as described in Section 32 12 14 – Subgrade and Roadbed.

3.2 DELIVERY AND SPREADING

- A. Aggregate base material shall be delivered to the roadbed as uniform mixtures; each layer shall be spread in one operation.
- B. At the time aggregate base is spread it shall have a moisture content sufficient to obtain the required compaction. Such moisture shall be uniformly distributed throughout the material.
- C. The material shall be spread upon the prepared subgrade by means of vehicles equipped with approved spreading devices at a uniform quantity per linear foot, which quantity will provide the required compacted thickness within the tolerances specified.
- D. Depositing and spreading shall commence at that part of the work farthest from the supply of base material and shall progress continuously without breaks, unless otherwise directed by the Geotechnical Engineer.
- E. Where the required thickness is six inches or less, the base material may be spread and compacted in one layer. Where the required thickness is more than six inches, the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed six inches. Each layer shall be spread and compacted in a similar manner.
- F. Base material placed in areas inaccessible to the spreading equipment may be spread in one or more layers by any means that will make possible the specified compaction and surface.
- G. When the subgrade for aggregate base consists of cohesionless sand, and written permission is granted by the Geotechnical Engineer, the base material may be dumped in piles upon the subgrade and spread ahead from the dumped material.
- H. The base material, after spreading, shall be shaped by means of a blade grader to such thickness that after watering and compacting, the completed base will conform to the required grade and cross section within the tolerances specified.
- I. Segregation of aggregate shall be avoided; the base shall be free from pockets of coarse or fine material.

3.3 COMPACTION

- A. Immediately following spreading, shaping, and smoothing, the full width of the base material shall be watered as ordered by the Geotechnical Engineer, and compacted by rolling with a minimum of two pieces of self-propelled reversible equipment. Compaction shall be as follows:
 - 1. For initial rolling use a 3-wheel steel-tired roller, weighing not less than 12 tons distributed so that the rear wheels will apply to the surface being rolled not less than 325 pounds per linear inch of rear tire width. Rolling shall commence by covering completely the outer edge of the material. Subsequent passes shall lap at least 25 percent on previously rolled material.
 - 2. For subsequent rolling use a pneumatic-tired roller of the oscillating type, having a width of not less than four feet and equipped with tires of equal size and diameter. Wobble wheel rollers will not be permitted. The tires shall be so spaced that the entire gap between adjacent tires will be covered by the tread of the following tire. The tires shall be inflated to 90 pounds per square inch minimum.
 - 3. To compact all areas inaccessible to the rollers, use compressed air or gas powered tampers.
- B. The foregoing equipment requirements serve as a standard of adequacy.
- C. Subject to the condition that the Contractor shall notify the Geotechnical Engineer at least ten (10) days in advance and shall secure approval for the use of each piece of compacting equipment other than that specified, selection thereof and obtainment of the specified compaction throughout the volume of base and the specified surface shall be solely the responsibility of the Contractor.
- D. If compaction is not uniform or tests show it to be inadequate, or if the surface is unsatisfactory, the Geotechnical Engineer may require the use of other or additional equipment.
- E. Should low or high spots develop during rolling operations, such spots shall be smoothed by blading with a self-propelled, pneumatic-tired motor grader having a wheelbase not less than 15 feet long and a blade not less than 10 feet long.
- F. Aggregate base shall be watered after compaction. Water shall be applied at the rate and in the quantities ordered by the Geotechnical Engineer.
- G. The relative compaction of aggregate base, determined by tests of the in-place, field compacted base shall be not less than 95 percent of the maximum compaction at optimum moisture content determined by ASTM Methods of Test, Designation D 1556 and Method C of Designation D 1557. The tests will be conducted and evaluated in the laboratory by the Geotechnical Engineer at no cost to the Contractor.
- H. The surface of the finished aggregate base at any point shall not vary more than 0.05 foot above or below proper grade; such surface shall contain no ridges, valleys or sharp breaks.

- I. Finished base that does not conform to the foregoing requirements shall be reshaped or reworked, watered, and thoroughly recompact to conform thereto.
- J. The Contractor shall not allow any completed untreated rock base to be subject to public or construction traffic, except the latter necessary to the completion of the overlying surface courses.

END OF SECTION 32 12 15

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SECTION 32 12 16 - ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: This section covers the work necessary for construction of the asphalt concrete leveling course and surface course used for paving roadways and parking areas, and the repair and replacement of existing pavement that has been disturbed by trenching or other construction.
- B. Related Sections:
 - 1. See Division 1 - General Requirements, which contain information and requirements that apply to the work specified herein.

1.2 SUBMITTALS

- A. Submittals during construction shall be made in accordance with Division 1, General Requirements.
- B. Product data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section;
 - 2. Certificates, signed by the materials producer and the asphalt paving subcontractor, stating that materials meet or exceed the specified requirements.

1.3 QUALITY ASSURANCE

- A. Standards: The following shall form a part of this specification and shall have the same force as if reproduced in total herein:
 - 1. Standard Specifications.
 - 2. Materials Manual of Testing and Control Procedures, State of California, Business and Transportation Agency, Department of Transportation, herein after referred to as "Materials Manual".
 - 3. ASTM D 1577 shall be used for the method of performing compaction tests.

PART 2 - PRODUCTS

2.1 ASPHALT

- A. Asphalt concrete surfacing shall consist of a mixture of mineral aggregate and paving grade asphalt, mixed at a central mixing plant.
 - 1. Asphalt concrete shall be as required by jurisdiction.
 - 2. Grade of asphalt shall be AR-4000 or AR-8000 as required.
 - 3. Density shall be 95% of maximum laboratory density as determined by California Test Method 304.
 - 4. Stability shall be 30 minimum.
 - 5. Mineral aggregate shall be Type B, 1/2" maximum size aggregate, medium grading, and shall conform to the following requirements:
 - a) The particle size distribution shall be in accordance with the grading specified for 1/2-inch maximum size aggregate.

<u>Sieve Size</u>	<u>Maximum Percentage Passing</u>
3/4-Inch	100
1/2-Inch	95-100
3/8-Inch	80-85
No. 4	54-64
No. 8	38-48
No. 30	20-30
No. 200	3-8

- 6. Drying, proportioning and mixing of the materials shall conform to Section 39 of the Caltrans Standard Specifications.
- B. Slurry Seal Coat shall be a Type II slurry seal and shall be a one coat process, or approved equivalent. The manufacturer shall supply the product in sealed containers, or provide certification of manufacturer to the Engineer.
- C. Seal Coat shall be equal to SS1H one coat process, or approved equivalent. The manufacturer shall supply the product in sealed containers, or provide certification of manufacturer to the Engineer.

2.2 AGGREGATE

- A. Aggregate base shall conform to the provisions of Section 32 12 15 Aggregate Base and as provided herein.
 - 1. The grading of the aggregate shall be "1/2 - inch Maximum, Medium" as described hereon, except in conform or overlay areas, the grading shall be 3/8 - inch maximum.
- B. Sampling and testing will not be required. The Contractor shall provide test results as indicated in this section.

2.3 COMPOSITION OF MIXTURE

- A. At least thirty (30) days prior to producing any of the mixture for use in the paving, the Contractor shall submit to the Engineer for approval a job - mix formula which meets the requirements herein specified. No asphalt pavement work shall be undertaken by the Contractor until the Engineer has reviewed the job - mix formula.
- B. The Contractor shall be responsible for locating an acceptable source of aggregate. All tests confirming the suitability of the material for the purpose intended shall be obtained by the Contractor at the Contractor's expense. Certified copies of the aggregate test results from an independent testing laboratory shall be furnished to the Engineer for review at least one week prior to delivery of aggregate to the site or use of aggregate in asphalt concrete.
- C. The Contractor shall make arrangement and pay for preparation of the asphalt concrete job mix formula. The job - mix formula for the asphalt concrete mixture shall establish the percentage of aggregate passing each sieve size, and the percentage of bituminous material to be added to said aggregate, and the temperature at which test results from a qualified, independent testing laboratory confirming the job - mix formula shall be submitted by the Contractor to the Engineer for review at least two weeks prior to the start of asphalt concrete paving. Any proposed deviations from the original job - mix formula shall be resubmitted by the Contractor for review. Test results of aggregate used in asphalt shall be provided as indicated in this section.
- D. The job - mix formula shall indicate the gradation of each of the several aggregate constituents to be used in the mixture and shall establish the exact proportion of each constituent to be used to produce a combined gradation of aggregate within the appropriate limits stated above.
- E. After a job - mix formula is established and reviewed, all mixtures furnished under this Contract shall conform to the requirements and tolerances as stated in these Specifications.

2.4 WEED CONTROL

- A. Spray applied herbicide, currently approved for designated use by all applicable agencies, including air pollution control jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION OF PARKING LOT

- A. Subgrade shall be fine graded per Section 31 20 00 Earth Moving and Section 32 12 14 Subgrade and Roadbed. The finished subgrade shall be tested and approved by the Geotechnical Engineer prior to the placement of aggregate base.
- B. Thoroughly blend base course aggregate on the job site. Construction shall conform to applicable portions of Section 26 of Caltrans Standard Specifications. Base material shall be placed, watered as required and mechanically compacted until a relative compaction of 95% has been obtained for the entire thickness of the base. Each layer of base course shall be tested and approved by the testing laboratory prior to the placement of successive layers. Compacted base thickness shall be as indicated on the drawings.
- C. Apply herbicide chemical to all areas to receive paving in strict accordance with the printed instructions of the manufacturer. Take all necessary safety precautions to protect against damage or injury due to its poisonous nature. No weed-control chemical is to be applied to areas designated for planting.
- D. A tack coat of asphalt applied at the rate of 0.05 to 0.12 gallons per square yard shall be applied uniformly to all surfaces on which any course of asphalt concrete is to be placed.
- E. The tack coat shall be emulsified asphalt. The emulsified asphalt may be mixed with water at the rate of 1 to 2 parts water to 1 part of emulsified asphalt.
- F. Preparation of Untreated Roadway
 - 1. A prime coat shall be applied over the full length of the project, and asphalt concrete pavement shall not be placed until the prime coat has cured.
 - 2. Should any holes, breaks, or irregularities develop in the roadway surface after the prime coat has been applied, they shall be patched with asphalt concrete immediately in advance of placing the asphalt concrete. The Contractor shall maintain the completed prime coat by blading or brooming with motor patrol graders, until the asphalt concrete is placed.
 - 3. After the maintenance, patching or repair work has been completed and immediately prior to placing the asphalt concrete pavement, the surface of the prime coat shall be swept clean of all dirt, dust or other foreign matter.

3.2 ASPHALT CONCRETE PAVEMENT

- A. The proportioning and mixing of asphalt concrete shall conform to the provisions provided herein. The pounds of asphalt per 100 pounds of dry aggregates shall not vary by more than 5% above or 10% below the amount indicated in the job - mix formula. This requirement shall apply to samples taken from a single batch, successive batches, at different locations in the production plant, or at any location

on the construction site.

- B. Paint binder shall be applied in conformance with the provisions provided herein.
- C. Spreading equipment and methods shall conform to the provisions provided herein. No asphalt concrete shall be placed on any section of compacted aggregate base that has not been reviewed by the Geotechnical Engineer.
- D. The asphalt concrete shall be compacted in accordance with the provisions provided herein. The weight and pressure of the Contractor's pneumatic tired roller will be reviewed, but not designated or approved, by the Geotechnical Engineer.
- E. Confirm areas associated with placement of asphalt concrete conform to the provisions provided herein.

3.3 PLACEMENT OF ASPHALT CONCRETE PAVING

- A. Install the specified curbs, and headers and stakes, to achieve the arrangement of paving shown on the drawings. All unconfined edges shall be confined with 2 inch by 4 inch redwood header boards staked with a 1 inch by 3 inch redwood stake 18 inches long minimum at 6 feet on-center. Two 1 inch by 4 inch pieces may installed together for bending along curves. Offset all joints by 2 feet.
- B. Remove all loose materials from the compacted base.
- C. Apply the specified prime coat, and tack coat where required, and allow to dry, in accordance with the manufacturer's recommendations as approved by the Engineer.
- D. Asphalt paving shall be installed in minimum lifts of 1.5 inches.
- E. Adjust frames, covers and utility vaults, if so required, to meet final grades.
- F. Do not accept receipt of asphalt concrete material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 280 degrees Fahrenheit.

3.4 CONNECTIONS WITH EXISTING FACILITIES

- A. Where it is necessary to remove existing asphalt surfaces or oil mat surfaces to provide proper meet lines and riding surfaces, the Contractor shall burn or chip the existing surface so that there will be sufficient depth to provide a minimum of one inch of asphalt concrete, and the waste material shall be disposed of to the satisfaction of the Engineer and Federal, State and Local Ordinances. Prior to placing the asphalt concrete these areas shall be tacked. Meet lines shall be straight and the edges vertical. The edges of meet lines cuts shall be painted with liquid asphalt or emulsified asphalt prior to placing asphalt concrete. After placing the asphalt concrete, the meet line shall be sealed by painting with a liquid asphalt or emulsified asphalt and immediately covered with clean, dry sand.
- B. Prior to laying the second strip of asphalt concrete pavement, the edge of the first strip laid and other contact surfaces such as curbs, manhole frames, and similar materials shall be painted with emulsified asphalt or liquid asphalt to provide closely

bonded watertight joints. This work shall be done in a manner that will prevent staining adjacent surfaces not intended to be coated.

3.5 COMPACTION

- A. Rolling shall continue until all roller marks are eliminated and a minimum density of 140 pcf has been obtained.
- B. Field density tests shall be made by a commercial testing laboratory retained by the Owner, and the test results submitted to the Geotechnical Engineer for review.

3.6 JOINTS

- A. The placing of the top or wearing course shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued for such length of time as to permit the mixture to become chilled.
- B. When the work is resumed the previously compacted mixture shall be cut back to produce a slightly beveled edge of the full thickness of the course. The material which is cut away shall be wasted and new mix shall be laid against the fresh cut. Rollers or tamping irons shall be used to seal the joints.

3.7 SURFACE TOLERANCE

- A. Tests for Conformity with the specified crown and grade shall be made by the Contractor immediately after initial compression. Any variation shall be immediately corrected by the removal or addition of materials and by continuous rolling.
- B. The completed surface of the top of wearing course shall be of uniform texture, smooth, uniform as to crown and grade and free from defects of all kinds. The completed surface shall not vary more than 1/8 inch from the lower edge of a 10 foot straight edge placed on the surface parallel to the centerline.
- C. After completion of the final rolling, the smoothness and grade of the surface shall again be tested by the Contractor.
- D. When deviations in excess of the above tolerances are found, the pavement surface shall be corrected by the addition of asphalt concrete mixture of an appropriate class to low places or the removal of material from high places by methods satisfactory to the Engineer, or by removal and replacement of the wearing course of asphalt concrete. Correction of defects shall be carried out until there are not deviations anywhere greater than the allowable tolerances.
- E. All areas in which the surface of the completed pavement deviates more than twice the allowable tolerances described above shall be removed and replaced to the satisfaction of the Engineer.

- F. All costs involved in making the corrections of defects described above shall be borne by the Contractor and no compensation will be made for this work.

3.8 APPLICATION OF SEAL OR SLURRY COAT

- A. Areas that have received new AC shall have a minimum 30 day cure time prior to application of either seal or slurry coat.
Prepare the surfaces, mix the seal coat material, and apply in accordance with the manufacturer's recommendations as approved by the Geotechnical Engineer.
- B. Apply one coat of the specified sealer.
- C. Achieve a finished surface seal which, when dry and thoroughly set, is smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.

3.9 SAMPLES

- A. The contractor shall, without additional charge, provide the Geotechnical Engineer with test results of samples of asphalt concrete cut from the completed pavement or the individual courses thereof. The minimum number of test cores shall be two per day during paving. The number of cores shall be increased if problems are indicated. The contractor shall also provide the Geotechnical Engineer with test results or samples of the uncompressed asphalt concrete mixtures, and all materials incorporated in the work.

3.10 UNFAVORABLE WEATHER

- A. Asphalt for prime coat shall not be applied when the ground temperature is lower than 50 degrees F without written permission of the Geotechnical Engineer.
- B. Asphalt concrete shall not be placed when the atmospheric temperature is less than 40 degrees F nor during heavy rainfall.

3.11 ALLOWABLE TOLERANCES

- A. Surface Smoothness:
 - 1. The surface of the finished base course shall not vary more than 3/8 inch, plus or minus, in 10 feet.
 - 2. The surface of the finished asphalt concrete shall not vary more than 1/4 inch, plus or minus, in 10 feet.
- B. The compacted paving or base course thickness shall not vary more than 1/4 inch, plus or minus, based on an average of five (5) measurements per 10,000 square feet, taken at randomly selected locations by testing laboratory.

- C. Provide hot plant mixed asphalt concrete paving materials:
 - 1. Temperature leaving the plant shall be 290 degrees Fahrenheit minimum, 320 degrees Fahrenheit maximum.
 - 2. Temperature at time of placing shall be 280 degrees Fahrenheit minimum.

3.12 SURFACE FINISH

- A. Surface finish shall be uniform and consistent in color and texture throughout the extents of the project and shall be achieved, at a minimum, by applying a slurry coat.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide Portland cement concrete paving where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related Work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 32 16 00 - Concrete Curbs, Gutters and Sidewalks

1.2 QUALITY ASSURANCE

- A. 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.
- B. Do not commence placement of concrete until mix designs have been reviewed and approved by the Architect and all governmental agencies having jurisdiction, and until copies of the approved mix designs are at the job site and the batch plant.
- C. Provide access for, and cooperate with, the inspector and testing laboratory described in Section 01 40 00 – Quality Requirements.
- D. Per CBC 2019 11B-302.1 General: Floor and ground surfaces shall be stable, firm, and slip resistant and shall comply with Section 11B-302.

1.3 PRODUCT HANDLING

- A. Comply with pertinent provisions of Section 01 60 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 FORMS

- A. Forms shall be made of wood or metal or other material capable of supporting mechanical concrete placing equipment without settling vertically, bowing inward or outward, or crushing. Forms shall have sufficient rigidity to maintain the lines and

grades shown on the Drawings within a vertical tolerance of 0.05 feet and an alignment tolerance of 1" at any point. Forms shall be clean and free of dirt, rust, and hardened concrete.

- B. Earth forms will not be permitted for paving.

2.2 REINFORCEMENT

- A. Comply with the following as minimums:
 - 1. Bars: ASTM A615, grade 60, unless otherwise shown on the Drawings, use deformed bars for number 3 and larger.
 - 2. Welded wire fabric: ASTM A185.
 - 3. Bending: ACI318.
- B. Fabricate reinforcement to the required shapes and dimensions, with fabrication tolerances complying with the CRSI "Manual of Standard Practices". Do not use reinforcement having any of the following defects:
 - 1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances;
 - 2. Bends or kinks not indicated on the Drawings or required for the work;
 - 3. Bars with cross-section reduced due to excessive rust or other causes.
- C. Joint reinforcement:
 - 1. Dowel bars shall be plain bars.
 - 2. Tiebars shall be deformed bars.
 - 3. Dowel bars and tiebars shall be of sizes indicated in the Project Drawings.

2.3 CONCRETE

- A. Comply with the following as minimums:
 - 1. Portland cement: ASTM C150, type I or II, low alkali.
 - 2. Aggregate, general:
 - a. ASTM C30, uniformly graded and clean;
 - b. Do not use aggregate known to cause excessive shrinkage.
 - 3. Aggregate, coarse: Crushed rock or washed gravel with maximum size between $\frac{3}{4}$ " and 1-1/2", and with minimum size number 4.
 - 4. Aggregate, fine: Natural washed sand of hard and durable particles varying from fine to particle passing a 3/8" screen, of which at least 12% shall pass a 50-mesh screen.
 - 5. Water: Clean and potable.
 - 6. 4" Max Slump
 - 7. W/CM Ratio of equal or less than 0.52
 - 8. Air-Entraining Ad Mixture shall meet ASTM C260, and shall be between 4% & 8%
- B. Use only such additives as are recommended in the mix design submitted by the Contractor and approved by the Architect and governmental agencies having jurisdiction.

- C. Provide concrete in the proportions established by the mix design required under Section 01400 – Quality Requirements of these Specifications, and to the compressive strength shown on the Drawings.

2.4 MEMBRANE-FORMING CURING COMPOUNDS

- A. Comply with ASTM C 309, Type 2, Class A.

2.5 ISOLATION JOINT MATERIAL

- A. Comply with ASTM D 1751 or ASTM D 1752.

2.6 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper elimination of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINAL PREPARATION OF SUBGRADES

- A. After preparation of subgrade as specified in Section 32 12 14 - Subgrade and Roadbed, thoroughly scarify and sprinkle the entire area to be paved, and then compact to a smooth, hard, even surface of 95% compaction to receive the aggregates.

3.3 PLACEMENT OF BASE COURSE

- A. Base (where required):
 1. Spread the specified coarse aggregate to a thickness providing the compacted thickness shown on the Drawings.
 2. Compact to 95%.
- B. Sand (where required)
 1. Spread the specified sand to a thickness providing the compacted thickness shown on the Drawings.

2. Compact to 95%.
- B. Thickness Tolerance: Provide the compacted thickness shown on the Drawings within a tolerance of minus 0.0" to plus 0.5".
- C. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 0.05 feet vertically and 1" in alignment at any point.
- D. Correct deviations by removing materials, replacing with new materials, and reworking or recompacting as required.
- E. Use only the amount of moisture needed to achieve the specified compaction.

3.4 INSTALLATION

- A. Upon completion of base course and formwork, install reinforcement as shown on the Drawings.
 1. Clean reinforcement to remove loose rust and mill scale, earth, and other materials that reduce bond or destroy bond with concrete.
 2. Position, support, and secure reinforcement against displacement by formwork, construction, and concrete placement operations.
 3. Place reinforcement to obtain the required coverages for concrete protection.
- B. Transmit mix the concrete in accordance with provisions of ASTM C94.
 1. With each load, provide ticket certifying to the materials and quantities and to compliance with the approved mix design.
 2. On the transit-mix ticket, state the time water was first added to the mix.
 3. At the batch plant, withhold 2-1/2 gal of water per cu yd of concrete.
 4. Upon arrival at the job site, and as directed by the testing laboratory inspector, add all or part of the withheld water before the concrete is discharged from the mixer.
 5. Mix not less than five minutes after the withheld water has been added, and not less than one minute of that time immediately prior to discharge of the batch.
 6. Unless otherwise directed, provide 15 minutes total mixing time per batch after first addition of water.
- C. Do not use concrete that has stood over 30 minutes after leaving the mixer, or concrete that is not placed within 60 minutes after water is introduced into the mix.
- D. Conveying:
 1. Place concrete in accordance with the following and pertinent recommendations contained in ACI 304.
 2. Deposit concrete continuously in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or places of weakness within the section.
 3. If a section cannot be placed continuously, provide construction joints as specified herein.

4. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic.
 5. Deposit concrete as nearly as practicable in its final location so as to avoid segregation due to rehandling and flowing.
 6. Do not subject concrete to any procedure which will cause segregation.
 7. Do not use concrete which becomes non-plastic and unworkable, or does not meet required quality control limits, or has been contaminated to foreign materials.
 8. Remove any rejected concrete from the site.
- E. Deposit and consolidate concrete in a continuous operation within the limits of construction joints until the placing of a panel or section is completed.
1. Bring surfaces to the correct level with a straightedge, and then strike off.
 2. Use bullfloats or darbies to smooth the surface. Do not disturb the surfaces prior to start of finishing operations.
- F. Finishing:
1. Begin floating when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation.
 2. During or after the first floating, check the planeness of surface with a ten-foot straightedge applied at not less than two different angles.
 3. Cut down high spots and fill low spots, and produce a surface level within 1/4" in two feet as determined by a two-foot straightedge placed anywhere on the surface in any direction.
 4. Re-float the surface immediately to a uniform sandy texture.
 5. While the surface is still plastic, provide a textured finish by drawing a fiber bristle broom uniformly over the surface.
 - a. Unless otherwise directed by the Architect, provide the texturing in one direction only.
 - b. Provide "light", "medium", or "coarse" texturing as directed by the Architect.

3.5 JOINTING

- A. Construct joints at locations, depths, and with dimensions indicated on the Project Drawings or accepted drawings submitted by the Contractor.
- B. If jointing requirements are not indicated on the Project Drawings or if submittals are required, the Contractor shall submit drawings describing jointing requirements in accordance with General Provisions, Submittal Procedures and the following requirements:
1. Indicate locations of all contraction joints, construction joints, and isolation joints. Locate joints at 12 feet on-center.
 2. The larger dimension of any panel shall not exceed 125 percent of the smaller dimension.
 3. The minimum angle between any two intersecting joints shall be 80 degrees.

4. Joints shall intersect pavement free edges at a 90-degree angle and shall extend straight for a minimum of 1.5 feet from the pavement edge
 5. Align joints of adjacent panes. Align joints in attached curbs with joints in pavement.
 6. Describe joint depths, widths, and keyway dimensions.
 7. Minimum contraction joint depth shall be one-fourth of the pavement thickness.
 8. Use isolation joints only where pavement abuts buildings, foundations, manholes, and other fixed objects.
- C. Construct contraction joints by one of the following methods:
1. Insert plastic strips vertically into the fresh concrete. Depress strips into pavement until flush with surface.
 2. Saw-cut concrete after concrete has hardened sufficiently to prevent aggregate being dislodged and soon enough to control pavement cracking. If contraction joint sawing causes a crack, discontinue sawing that contraction joint and continue sawing other contraction joints.
- D. Isolation joints:
1. Extend isolation joints through the full depth of the pavement. Fill the entire isolation joint with isolation joint material unless otherwise required by Project Drawings or accepted jointing drawings submitted by the Contractor. (See Section 3.05.B).
 2. Extend isolation joints through the full depth of the pavement. Fill the entire isolation joint with isolation joint material.
 3. Do not permit reinforcement to extend continuously through any expansion joint.
 4. Locate isolation joints at all beginning and ending of curves, filled to full depth with expansion joint material.
 5. In curbs, locate $\frac{1}{2}$ " thick joint at the beginning and end of curves, and at a maximum of 40' centers elsewhere unless otherwise shown on the plans.
 6. In curbs and paving, hold down $\frac{1}{2}$ " and seal exposed joints with a joint sealer.

3.6 CURING AND PROTECTION

- A. Beginning immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures and mechanical injury.
- B. Apply membrane-forming curing compound to all exposed surfaces at a maximum coverage rate of 200 sq.ft./gal. Apply curing compound immediately after final surface texture has been obtained and water sheen has disappeared. Apply curing compound to pavement edges after forms have been removed.
- C. Alternate curing methods may be used when specified and approved by the engineer.

3.7 TOLERANCES

- A. The entire site is subject to frequent pedestrian traffic, and is subject to the guidelines presented in the Americans with Disabilities Act. Where stated on plans or where required by the ADA, the slopes are not to exceed the maximums set forth in this act.

END OF SECTION 32 13 13

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SECTION 32 16 00 - CONCRETE CURBS, GUTTERS AND SIDEWALKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Section Includes: This section covers the work necessary to completely construct the concrete curbs, gutters and sidewalks.
- B. Related Work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 32 13 13 Concrete Paving

1.2 SUBMITTALS

- A. Submit Product Information and Mix Design, Certification, Test Results, and Source of Expansion Joint Filler.

PART 2 - PRODUCTS

2.1 FORMS

- A. Materials for curb and gutter shall be 2-inch dressed dimension lumber or of metal of equal strength, free from defects which would impair the appearance or structural quality of the completed curb. Where short- radius forms are required, 1-inch dressed lumber or plywood may be used. Form material for the face of the curb shall not have any horizontal joints closer than seven inches from the top of the curb. Provide stakes and bracing materials as required to hold forms securely in place. Metal forms shall be subject to approval of the Engineer.
- B. Materials for sidewalks shall be 2-inch dressed dimension lumber, straight and free of defects, or standard metal forms. Where short radius forms are required, 1-inch dressed lumber or plywood may be used. Provide stakes and bracing material as required to hold forms securely in place.

2.2 CRUSHED ROCK BASE

- A. Clean 3/4 inch minus crushed rock or crushed gravel, free from foreign material and meeting the requirements of Section 32 12 15 – Aggregate Base.

2.3 EXPANSION JOINT FILLER

- A. Expansion joint filler shall be 1/2 inch thick, premolded joint filler material. It shall consist of premolded strips of a durable resilient material. Premolded joint filler shall be one of the following:
 1. Preformed Expansion Joint Filler (Bituminous) conforming to ASTM D 994.
 2. Nonextruding and Resilient Filler (Bituminous) conforming to ASTM D 1751.
 3. Approved equal.

2.4 CONCRETE

- A. Concrete shall be ready-mixed, conforming to ASTM C 94, Alternate 2, and shall have a compressive strength of 2,500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inch. Slump shall be between two and four inches. Submit complete information regarding mix to the Engineer for review, in accordance with the requirements of the referenced ASTM Specifications.

2.5 CURING COMPOUND

- A. Liquid membrane-forming curing compound shall be clear or translucent, suitable for spray application and shall conform to ASTM C 309, Type 1.

2.6 ACCEPTANCE OF MATERIALS

- A. All materials shall be subject to inspection for suitability as the Engineer may elect, prior to or during incorporation into the work.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill required to accomplish the construction. After concrete forms have been removed and all debris cleaned up from the areas to be filled, place backfill from excavation in six inch lifts to grade and compact each lift thoroughly with pneumatic tamper or other suitable equipment to prevent future settlement. Dispose of all excess excavation offsite.

3.2 PREPERATION OF SUBGRADE

- A. Bring the area on which curbs, gutters and sidewalks to be constructed to required grade on undisturbed ground and compact by sprinkling and rolling or mechanical tamping. As depressions occur, refill with suitable material and recompact until the surface is at the proper grade. Subgrade shall be compacted to 95% of maximum density at optimum moisture content as determined by ASTM D 1557, Method C.

3.3 SETTING FORMS

- A. Construct forms to the shape, lines, grades and dimension called for on the Drawings. Stake wood or steel frames securely in place, true to line and grade.
- B. Forms on the face of the curb shall not have any horizontal joints within seven inches of the top of the curb. Brace forms to prevent change of shape or movement in any direction resulting from the weight of the concrete during placement. Construct short-radius curved forms to exact radius. Tops of forms shall not depart from gradeline more than 1/8 inch when checked with a 10 foot straight edge. Alignment of straight sections shall not vary more than 1/8 inch in 10 feet.

3.4 CURB CONSTRUCTION

- A. Construct curbs to line and grade shown or established by the Engineer. Curbs shall conform to the details shown.
- B. Ramps shall be constructed at pedestrian crossings as shown and in conformance with the legal requirements.
- C. Place preformed asphalt-impregnated expansion joints at intervals not exceeding 40 feet and at the beginning and end of curved portions of the curb; also at connections to existing curbs.
- D. Place weakend plane joints in the curb at intervals not exceeding 10 feet. Place, process, finish and cure concrete in accordance with the applicable requirements of ACI 614, and this Specification. Wherever the requirements differ, the higher shall govern. After initial set has occurred in the concrete and prior to removing the front curb form, the steel sheet shall be removed with a sawing motion. Finish top of curb with a steel trowel and finish edges with a steel edging tool.
- E. As soon as the concrete has set sufficiently to support its own weight, remove the front form and finish all exposed surfaces. Finish formed face by rubbing with a burlap sack or similar device that will produce a uniformly textured surface, free of form marks, honeycomb and other defects. All defective concrete shall be removed and replaced at the Contractor's sole expense. Upon completion of the finishing, apply an approved curing compound to exposed surfaces of the curb. Curing shall continue for a minimum of five days.

- F. Upon completion of the curing period, but not before seven days has elapsed since pouring the concrete, backfill the curb with earth, free from rocks two inches and larger and other foreign material. Tamp backfill firmly in place.
- G. Finished curb shall present a uniform appearance for both grade and alignment. Remove any section of curb showing abrupt changes in alignment or grade, or which is more than 1/4 inch away from its location as staked, and construct new curb in its place at the Contractor's sole expense.

3.5 SIDEWALK CONSTRUCTION

- A. Sidewalks shall be a minimum of four inches thick in walk areas and six inches thick in driveway areas. Refer to the Construction Drawings for additional detailing.
- B. At locations where the new sidewalk is to abut existing concrete, sawcut concrete for a depth of two inches and chip the old concrete back to sound material on a straight line, clean the surface, and apply a neat cement paste just prior to pouring the new sidewalk.
- C. Place preformed asphalt expansion joints as in the adjacent curb, where the sidewalk ends at a curb, and around posts, poles, or other objects protruding through the sidewalk.
- D. Provide weekend plane joints transversely to the walks at locations opposite the contraction joints in the curb. Plastic pulltop quickjoint strips or approved equal at 1-1/2 inch deep
- E. Place, process, finish and cure concrete in conformance with the applicable requirements of ACI 614 and this Specification. Where the requirements differ, the higher shall govern.
- F. At a minimum, broom the surface with a fine-hair broom at right angles to the length of the walk and tool at all edges, joints and markings or surface finish as required by the construction Drawings.. Mark the walks transversely at five-foot intervals with a jointing tool. Upon completion of the finishing, apply an approved curing compound to the exposed surfaces. Protect the sidewalk from damage for a period of seven days.

END OF SECTION

SECTION 32 17 25 - CAST-IN-PLACE TACTILE WARNING SURFACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cast-in-place Tactile Warning Surface (non-replaceable)
 - 2. Radius Cast-in-place Tactile Warning Surface

1.3 SUBMITTALS

- A. Submit list of materials proposed for use in work, in form of shop drawing, identified by manufacturer's name and product label prior to start of installation.
- B. Submit samples of colors and finishes. Obtain selection colors before proceeding with work.
- C. Product Data - Submit material specifications, manufacturer's installation, and maintenance instructions.
- D. Samples: Partial Unit with exposed finish for acceptance. Accepted unit will serve as standard of quality and workmanship for production units.
- E. Certification: Manufacturers certifications that all products furnished meet or exceed specified requirements.

1.4 REQUIREMENTS

- A. Material must comply with local, state, and federal air pollution control requirements and federal lead content requirements.
- B. Material must comply with California State Accessibility Standards, CCR Title 24.
- C. Material must comply with Americans with Disabilities Act (ADA) Accessibilities Guidelines for Buildings.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Colors selected are from a single manufacturer.
- B. Tile shall comply with requirements of Detectable Warnings on Walking Surfaces, of the Americans With Disabilities Act and California State Accessibilities Standards, Title 24.

1.6 PRODUCT HANDLING

- A. Protection: Products to be stored at the job site in a safe dry place with all labels intact and legible at time of installation.
- B. Replacements: In the event of damage, make repairs and replacements.
- C. Delivery and Handling: Deliver units to site at scheduled time of installation, and handled at the job site in the protective, shrink-wrapped pallets. Pallets shall be stored complete and unopened until time of use so that the units will not be discolored or soiled before installation and should be re-covered at the end of each workday.
- D. Transport: Transport units in manner so as to prevent, cracking, or spalling. Plastic sheeting protection covers required for shipping and delivery.

1.7 REGULATORY REQUIREMENTS

- A. Detectable warnings surfaces shall comply with CBC Section 11B-705.
- B. Detectable warning surfaces shall be yellow conforming to FS 33538 of Federal Standard 595C, except for locations at curb ramps, islands, or cut-through medians where color used shall contrast visually with that of adjacent walking surfaces, either light-on-dark, or dark-on-light. CBC Sections 11B-705.1.1.3 and 11B-705.1.1.5.
- C. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact. CBC Section 11B-705.1.1.4.
- D. Provide minimum 5-year warranty per DSA Bulletin 10/31/02, revised 04/09/08.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Cast-in-place Tactile Warning Surface: Subject to compliance with requirements, provide either the named product or an equal product by one of the other manufacturers specified.
 - 1.2.1.1.1 ADA Solutions, LLC; Toll Free Tel: (800) 372-0519. 323 Andover Street – Suite 3
Wilmington, MA 01887 (*Basis of Design*)
 - 1.2.1.1.2 Armor-Tile (800) 682-2525. Engineered Plastics, 300 International Dr, Suite 100,
Williamsville, NY 14221

1.2.1.1.1.3 Vitrified Polymer Composite (VPC) Cast In Place Detectable/Tactile Warning Tile specified is based on Armor-Tile manufactured by Engineered Plastics Inc. (800-682-2525).

1.2.1.1.1.4 Or equal (Reference substitution requirements in Division 1)

B. Dimensions

1. Tile shall contain truncated domes with a diameter of 0.90-0.92 inch at base tapering to 0.45-0.47 inch at the top, a height of nominal 0.2 inch and a center to-center spacing of nominal 2.3"-2.4". [Figure 11B-705.1]
2. Size:
 - a) Cast-in-place panels shall be 1/4" nominal thickness with 1.375-inch embedment ribs at 3" o.c. through the entire tile length. 24 inches x 24 inches x 2 inches thick
 - b) Available Sizes: Use sizes to keep the minimize the number of panels required.
 - i. 36 inches x 48 inches
3. Coefficient of friction shall be 0.6 minimum when tested in accordance with ASTM C 1028.
4. Consistent color throughout tile. Cure units to develop concrete quality and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
5. Units exhibiting evidence of extensive repairs will not be accepted.

C. Materials:

1. Homogeneous glass, carbon and reinforced composite material with embedment ribs for structural support.

2.2 COLOR SELECTIONS

- A. Color selected shall be as selected by the Owner's Representative from full manufactures range to contracts with adjacent surfaces.

2.3 SOURCE QUALITY CONTROL AND TESTING

- A. Testing: sampling and testing in accordance with manufactures standard procedures, subject to the engineer's acceptance.

PART 3 – EXECUTION

3.1 GENERAL

- A. Install truncated domes in conformance with manufacturer's specifications and substrate requirements.
 - 1. Verify layout of work before beginning work.
 - 2. Verify substrate is acceptable for placing units in place.
 - 3. Beginning of work means acceptance of existing conditions.

3.2 INSTALLATION

- A. Spread and screed mortar setting bed mixture true to plane. Limit setting bed to one tile prior to initial set.
- B. Set and level each tile immediately. Tamp tiles to complete contact with setting bed. Do not set large areas of tiles for later leveling.
- C. Remove excess mortar from face of tiles as work progresses while mortar is fresh.
- D. Replacement: Replace tile work showing damage or disfiguration during progress of work in its entirety. Patching or hiding of defects is not permitted.

3.3 GROUTING AND CLEANING

- A. Grouting: Grout joints as soon as initial set or setting bed is achieved.
- B. Cleaning: Remove grout haze with manufacturer approved cleaner.

3.4 SEALANT

- A. Seal with two coats of manufacturers sealing product or product designated by manufacturer designed for precast concrete penetration.
- B. Sealant shall protect units against all weather conditions
- C. Sealant shall protect units against graffiti.
- D. Coefficient of friction of 0.6 shall be maintained.

3.5 PROTECTION

- A. Protect surfaces and objects adjacent to work area, grounds, lawns, shrubbery, and adjacent properties against damage. Be responsible for storage of materials, removal of combustible rags, empty containers, etc., at end of each day, taking every possible precaution to prevent fire.

END OF SECTION 32 17 25

SECTION 32 84 00 - LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.11 SUMMARY

- A. It is the intent of the specifications and drawings that the finished system is complete in every respect and shall be ready for operation satisfactory to the Owner.
- B. The work shall include all materials, labor, services, transportation, and equipment necessary to perform the work as indicated on the drawings, in these specifications, and as necessary to complete the contract.

1.12 CONSTRUCTION DRAWINGS

- A. Due to the scale of the drawings, it is not possible to indicate all offsets, fittings, sleeves, etc. which may be required. The 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 irrigation systems, planting, utilities, site furnishings and architectural features.
- B. All work called for on the drawings by notes or details shall be furnished and installed whether or not specifically mentioned in the specifications. When an item is shown on the plans but not shown on the specifications or vice versa, it shall be deemed to be as shown on both. The Landscape Architect shall have final authority for clarification.
- C. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that 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 the Landscape Architect for further direction as soon as detected. In the event this notification is not performed, the Irrigation Contractor shall assume full responsibility for any revision necessary.

1.13 QUALITY ASSURANCE

- A. Provide at least one English speaking person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation and who shall direct all work performed under this section.

- B. Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturer of articles used in this contract furnishes directions covering points not shown in the drawings and specifications.
- C. All local, municipal, and state laws, 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 the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules and regulations of the same. 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. All materials supplied for this project shall be new and free from any defects. All defective materials shall be replaced immediately at no additional cost to Owner.
- E. The Contractor shall secure the required licenses and permits including payments of charges and fees, give required notices to public authorities, verify permits secured or arrangements made by others affecting the work of this section.

1.14 SUBMITTALS

- A. Submittals Materials List:
 - 1. After award of contract and before any irrigation system materials are ordered from suppliers or delivered to the job site, submit to the Owner a complete list of all irrigation system materials, or processes proposed to be furnished and installed as part of this contract.
 - 2. The submittals materials list shall include the following information:
 - a. A title sheet with the job name, the contractor's name, contractor's address and telephone number, submittal date and submittal number.
 - b. An index sheet showing the item number (i.e. 1, 2, 3, etc.); an item description (i.e. sprinkler head); the manufacturer's name (i.e. Hunter Industries); the item model number (i.e. I-40-ADV/36V); and the page(s) in the submittal set that contain the catalog cuts.
 - c. The catalog cuts shall be one or two pages copied from the most recent manufacturer's catalog that indicate the product submitted. Do not submit parts lists, exploded diagrams, price lists or other extra information. Do submit the operational characteristics of equipment.
 - d. The catalog cuts shall clearly indicate the manufacturer's name and the item model number. The item model number, all specified options and specified sizes shall be circled on the catalog cuts.

- e. Submittals for equipment indicated on the legend without manufacturer names, or "as approved", shall contain the manufacturer, Class or Schedule, ASTM numbers and/or other certifications as indicated in these specifications.
3. Submittal materials list format requirements:
 - a. Submittals shall be provided as one complete package for the project. Multiple partial submittals will not be reviewed.
 - b. Submittal package shall be stapled or bound in such a way as to allow for disassembly for review processing. Submittals shall not have tabs, tab sheets, spiral binding, or any other type of binding that will interfere with automated copying of submittals.
 - c. Submittal package shall have all pages numbered in the lower right hand corner. Page numbers shall correspond with submittal index.
 - d. Re-submitted packages must be revised to include only the equipment being re-submitted. Equipment previously reviewed and accepted shall not be re-submitted in the materials list/index sheet or in the catalog cut sheet package.
- B. Substitutions: If the Irrigation Contractor wishes to substitute any equipment or materials for those equipment or materials listed on the irrigation drawings and specifications, he may do so by providing the following information to the Landscape Architect or Owner's authorized representative for approval.
 1. Provide a written statement indicating the reason for making the substitution.
 2. Provide catalog cut sheets, technical data, and performance information for each substitute item.
 3. Provide in writing the difference in installed price if the item is accepted.
- C. The Landscape Architect or Owner's authorized representative will allow no substitutions without prior written acceptance.
- D. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.
- E. The Landscape Architect or Owner's authorized representative will not review the submittal package unless provided in the format described above.

1.15 EXISTING CONDITIONS

- A. The Contractor shall verify and be familiar with the locations, size and detail of points of connection provided as the source of water, and electrical supply connection to the irrigation system.

- B. Irrigation design is based on the available static water pressure shown on the drawings. Contractor shall verify static water on the project prior to the start of construction. Should a discrepancy exist, notify the Landscape Architect and Owner's authorized representative prior to beginning construction.
- C. Prior to cutting into the soil, the Contractor shall locate all cables, conduits, sewer septic tanks, and other utilities as are commonly encountered underground and he shall take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the Contractor shall promptly notify the Landscape Architect and Owner who will arrange for relocations. The Contractor will proceed in the same manner if a rock layer or any other such conditions are encountered.
- D. The Contractor shall protect all existing utilities and features to remain on and adjacent to the project site during construction. Contractor shall repair promptly, at his own cost; all damage resulting from his operations or negligence.
- E. The Irrigation Contractor shall coordinate with the General Contractor for installation of required sleeving as shown on the plans prior to paving operations.
- F. The Contractor shall verify and be familiar with the existing irrigation systems in areas adjacent to and within the Project area of work.
- G. The Contractor shall protect all existing irrigation systems, in areas adjacent to and within the project area of work, from damage due to his operations.
- H. Contractor shall notify Owner's Representative if any existing system is temporarily shut off, capped or modified. Provide 48-hour notice, prior to turning off or modifying any existing irrigation system.
- I. The Contractor shall repair or replace all existing irrigation systems, in areas adjacent to and within the project area of work, damaged by the construction of this project. Adjacent irrigation systems shall be made completely operational and provide complete coverage of the existing landscaped areas. All repairs shall be complete to the satisfaction of the Owner's Representative.
- J. The contractor shall provide bore holes under any existing pavement or paving encountered for the required lateral, mainline and low voltage control wire sleeving. Bore holes under 2 inches in diameter and smaller shall be made with a BulletMole® underground boring tool as manufactured by Dimension Tools, LLC (Contact telephone number (888)-650-5554 or at www.bulletmole.com). Bore holes larger than 2 inches in diameter shall be made with an approved mechanical boring tool. No air jacking or hydraulic boring of any kind shall be allowed.

1.16 INSPECTIONS

- A. The Contractor shall permit the Landscape Architect and Owner's authorized representative to visit and inspect at all times any part of the work and shall provide safe access for such visits.
- B. Where the specifications require work to be tested by the Contractor, it shall not be covered over until accepted by the Landscape Architect, Owner's authorized representative, and/or governing agencies. The Contractor shall be solely responsible for notifying the Landscape Architect, Owner, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing. Should any work be covered without testing or acceptance, it shall be, if so ordered, uncovered at the Contractor's expense.
- C. Inspections will be required for the following at a minimum:
 - 1. Pre-construction meeting.
 - 2. System layout.
 - 3. Pressure test of irrigation mainline (Four hours at 125 PSI or 120% of static water pressure, whichever is greater.) Mainline pressure loss during test shall not exceed 2 PSI.
 - 4. Coverage test of irrigation system. Test shall be performed prior to any planting.
 - 5. Final inspection prior to start of maintenance period.
 - 6. Final acceptance prior to turnover.
- D. Site observations and testing will not commence without the field record drawings as prepared by the Irrigation Contractor. Record drawings must complete and up to date for each site visit.
- E. Work that fails testing and is not accepted will be retested. Hourly rates and expenses of the Landscape Architect, Owner's authorized representative, and governing agencies for re-inspection or retesting will be paid by the Irrigation Contractor at no additional expense to Owner.

1.17 STORAGE AND HANDLING

- A. Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installation work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Landscape Architect and Owner and at no additional cost to the Owner.
- B. Exercise care in handling, loading, unloading, and storing plastic pipe and fittings under cover until ready to install. Transport plastic pipe only on a vehicle with a bed

long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load.

1.18 CLEANUP AND DISPOSAL

- A. Dispose of waste, trash, and debris in accordance with applicable laws and ordinances and as prescribed by authorities having jurisdiction. Bury no such waste material and debris on the site. Burning of trash and debris will not be permitted. The Contractor shall remove and dispose of rubbish and debris generated by his work and workmen at frequent intervals or when ordered to do so by the Owner's authorized representative.
- B. At the time of completion the entire site will be cleared of tools, equipment, rubbish and debris which shall be disposed of off-site in a legal disposal area.

1.19 TURNOVER ITEMS

- A. Record Drawings:
 - 1. Record accurately on one set of drawings all changes in the work constituting departures from the original contract drawings and the actual final installed locations of all required components as shown below.
 - 2. The record drawings shall be prepared to the satisfaction of the Owner. Prior to final inspection of work, submit record drawings to the Landscape Architect or Owner's authorized representative.
 - 3. All record drawings shall be prepared using AutoCAD 2014 drafting software and the original irrigation drawings as a base. No manual drafted record drawings shall be acceptable. The Contractor may obtain digital base files from the Landscape Architect or Owner's authorized representative.
 - 4. If the Contractor is unable to provide the AutoCAD drafting necessary for the record drawings the irrigation designer does provide record drawing drafting as a separate service.
 - 5. Prior to final inspection of work, submit record drawings plotted onto vellum sheets for review by the Landscape Architect or Owner's authorized representative. After acceptance by the Landscape Architect, City Inspector or Owner's authorized representative re-plot the record drawings onto reproducible Mylar sheets. The Contractor shall also provide record drawing information on a digital AutoCAD Release 2014 drawing file. All digital files shall be provided on a compact disc (CD) clearly marked with the project name, file descriptions and date.
 - a. Record drawing information and dimensions shall be collected on a day-to-day basis during the installation of the pressure mainline to fully indicate all routing locations and pipe depths. Locations for all other irrigation equipment shall be collected prior to the final inspection of the work.

- b. Two dimensions from two permanent points of reference such as buildings, sidewalks, curbs, streetlights, hydrants, etc. shall be shown for each piece of irrigation equipment shown below. Where multiple components are installed with no reasonable reference point between the components, dimensioning may be made to the irrigation equipment. All irrigation symbols shall be clearly shown matching the irrigation legend for the drawings. All lettering on the record drawings shall be minimum 1/8 inch in size.
 6. Show locations and depths of the following items:
 - a. Point of connection (including water POC, backflow devices, master control valves, flow sensors, etc.)
 - b. Routing of sprinkler pressure main lines (dimensions shown at a maximum of 25 feet along routing)(also indicate any unusual location and depth of cover where not installed at the specified location and depth)
 - c. Sleeves and conduits (indicate purpose used for, size, quantity, depth of cover)
 - d. Isolation valves
 - e. Automatic remote control valves (indicate station number and size)
 - f. Quick coupling valves
 - g. Drip air vacuum relief valves and flush valves
 - h. Routing of control wires (indicate color)
 - i. Irrigation controllers (indicate controller number and station count)
 - j. Ground rods
 - k. Related equipment (as may be directed)
 - l. Any hazardous or potential hazardous underground conditions encountered and deviated around
- B. Controller Charts:
1. Provide one controller chart for each automatic controller. Chart shall show the area covered by the particular controller. The areas covered by the individual control valves shall be indicated using colored highlighter pens. A minimum of six individual colors shall be used for the controller chart unless less than six control valves are indicated.
 2. Landscape Architect or Owner's authorized representative must approve record drawings before controller charts are prepared.
 3. The chart is to be a reduced copy of the actual "record" drawing. In the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a readable size.
 4. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils in thickness.
- C. Operation and Maintenance Manuals:

1. Two individually bound copies of operation and maintenance manuals shall be delivered to the Landscape Architect or Owner's authorized representative at least 10 calendar days prior to final inspection. The manuals shall describe the material installed and the proper operation of the system.
 2. Each complete, bound manual shall include the following information:
 3. Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment including names and addresses of local manufacturer representatives.
 - a. Operating and maintenance instructions for all equipment.
 - b. Spare parts lists and related manufacturer information for all equipment.
 4. List of local irrigation suppliers (include name, address and phone number)
- D. Equipment:
1. Supply as a part of this contract the following items:
 - a. Two (2) wrenches for disassembly and adjustment of each type of sprinkler head used in the irrigation system.
 - b. Three 30-inch sprinkler keys for manual operation of control valves.
 - c. Two keys for each automatic controller.
 - d. Two quick coupler keys with a 1" bronze hose bib, bent nose type with hand wheel and two coupler lid keys.
 - e. One valve box cover key or wrench.
 - f. Two (2) extra sprinkler heads of each size and type, including nozzle screens.
 - g. 100 ft of each dripline of type installed, including 10 barbed coupling connectors
 2. The above equipment shall be turned over to Owner's authorized representative at the final inspection.

1.20 COMPLETION

- A. At the time of the pre-maintenance period inspection, the Landscape Architect, Owner's authorized representative, and governing agencies will inspect the work, and if not accepted, will prepare a list of items to be completed by the Contractor. Punch list to be checked off by contractor and submitted to Landscape Architect or Owner's Authorized representative prior to any follow-up meeting. This checked off list to indicate that all punch list items have been completed. At the time of the post-maintenance period or final inspection the work will be re-inspected and final acceptance will be in writing by the Landscape Architect, Owner's authorized representative, and governing agencies.
- B. The Owner's authorized representative shall have final authority on all portions of the work.

- C. After the system has been completed, the Contractor shall instruct Owner's authorized representative in the operation and maintenance of the irrigation system and shall furnish a complete set of operating and maintenance instructions.
- D. After the control system (controller, Ethernet and electrical connections, flow sensor and master valves, associated control wires) installation has been fully completed, and the irrigation systems are connected to the controller for automatic operation, the Contractor shall promptly notify the controller manufacturer to have the manufacturer's field technician review the completed control system installation and operation. Contractor shall provide the Owner's representative with a written copy of certification from the controller manufacturer for the control system as soon as installation is complete, and prior to final project acceptance by the Owner. Contractor shall make any necessary adjustments to provide certification.
- E. Any settling of trenches which may occur during the one-year period following acceptance shall be repaired to the Owner's satisfaction by the Contractor without any additional expense to the Owner. Repairs shall include the complete restoration of all damage to planting, paving or other improvements of any kind as a result of the work.

1.21 GUARANTEE

- A. The entire sprinkler system, including all work done under this contract, shall be unconditionally guaranteed against all defects and fault of material and workmanship, including settling of backfilled areas below grade, for a period of one (1) year following the filing of the Notice of Completion.
- B. Should any problem with the irrigation system be discovered within the guarantee period, it shall be corrected by the Contractor at no additional expense to Owner within ten (10) calendar days of receipt of written notice from Owner. When the nature of the repairs as determined by the Owner constitute an emergency (i.e. broken pressure line) the Owner may proceed to make repairs at the Contractor's expense. Any and all damages to existing improvement resulting either from faulty materials or workmanship, or from the necessary repairs to correct same, shall be repaired to the satisfaction of the Owner by the Contractor, all at no additional cost to the Owner.
- C. Guarantee shall be submitted on Contractors own letterhead as follows:

GUARANTEE FOR SPRINKLER IRRIGATION SYSTEM

We hereby guarantee that the sprinkler irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance

with the drawings and specifications, ordinary wear and tear and unusual abuse, or neglect excepted. We agree to repair or replace any defective material during the period of one year from date of filing of the Notice of Completion and also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within 10 calendar days following written notification by the Owner. In the event of our failure to make such repairs or replacements within the time specified after receipt of written notice from Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

PART 2 - MATERIALS

2.11 SUMMARY

Use only new materials of the manufacturer, size and type shown on the drawings and specifications. Materials or equipment installed or furnished that do not meet Landscape Architect's, Owner's, or governing agencies standards will be rejected and shall be removed from the site at no expense to the Owner.

2.12 PIPE

- A. Pressure supply line between the water meter and the backflow prevention device shall be Type K copper, one size larger than backflow device.
- B. Backflow prevention assemblies, and all other above grade assemblies, shall be constructed of threaded brass pipe and threaded brass fittings the same size as the backflow device, unless otherwise directed.
- C. Pressure supply lines 2 inches in diameter and up to 3 inches in diameter downstream of backflow prevention unit shall be Class 315 solvent weld PVC. Piping shall conform to ASTM D2241.
- D. Non-pressure (intermittent pressure) lines 3/4 inch in diameter and larger downstream of the remote control valve shall be SCH 40 solvent weld PVC conforming to ASTM D1785.

2.13 METAL PIPE AND FITTINGS

- A. Brass pipe shall be 85 percent red brass, ANSI, IPS Standard 125 pounds, Schedule 40 screwed pipe.
- B. Fittings shall be medium brass, screwed 125-pound class.

- C. Copper pipe and fittings shall be Type "K" sweat soldered, or brazed as indicated on the drawings.

2.14 PLASTIC PIPE AND FITTINGS

- A. Pipe shall be marked continuously with manufacturer's name, nominal pipe size, schedule or class, PVC type and grade, National Sanitation Foundation approval, Commercial Standards designation, and date of extrusion.
- B. All plastic pipe shall be extruded of an improved PVC virgin pipe compound in accordance with ASTM D2672, ASTM D2241 or ASTM D1785.
- C. All solvent weld PVC fittings shall be standard weight Schedule 40 (and Schedule 80 where specified on the irrigation detail sheet, all mainline fittings shall be Schedule 80 PVC) and shall be injection molded of an improved virgin PVC fitting compound. Slip PVC fittings shall be the "deep socket" bracketed type. Threaded plastic fittings shall be injection molded. All tees and ells shall be side gated. All fittings shall conform to ASTM D2464 and ASTM D2466.
- D. All threaded nipples shall be standard weight Schedule 80 with molded threads and shall conform to ASTM D1785.
- E. All solvent cementing of plastic pipe and fittings shall be a two-step process, using primer and solvent cement applied per the manufacturer's recommendations. Cement shall be of a fluid consistency, not gel-like or ropey. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.
- F. When connection is plastic to metal, female adapters shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be non-lead base Teflon paste, tape, or equal.
- G. All pressure mainlines installed with solvent weld PVC fittings shall be installed with concrete thrust blocking at all directional changes in the mainline routing. Concrete thrust blocking shall not be required when ductile iron fittings and mechanical restraints are specified.
- H. PVC electrical conduit shall be as specified on the irrigation plans.

2.15 VALVES

- A. Ball Valves:
 - 1. Ball valves shall be of the manufacturer, size, and type indicated on the drawings.
 - 2. Ball valves shall be constructed of a bronze or stainless steel body, stainless steel ball and stem. Ball valves shall have threaded connections.

3. All ball valves shall have a minimum working pressure of not less than 150 PSI and shall conform to AWWA standards.
- B. Quick Coupler Valves:
1. Quick coupler valves shall be of the manufacturer, size, and type indicated on the drawings.
 2. Quick coupler valves shall be brass with a wall thickness guaranteed to withstand normal working pressure of 150 psi without leakage. Valves shall have 1" female threads opening at base, with two-piece body. Valves to be operated only with a coupler key, designed for that purpose. Coupler key is inserted into valve and a positive, watertight connection shall be made between the coupler key and valve.
- C. Automatic Control Valves:
1. Automatic control valves shall be of the manufacturer, size, and type indicated on the drawings.
 2. Automatic control valves shall be electrically operated.
 3. Provide Christy's standard yellow valve ID tags for each remote control valve with valve number.

2.16 VALVE BOXES

- A. Valve boxes shall be fabricated from a durable, weather-resistant plastic material resistant to sunlight and chemical action of soils.
- B. The valve box cover shall be green in color and secured with a hidden latch mechanism or stainless steel bolts. Provide locking mechanism.
- C. The cover and box shall be capable of sustaining a load of 1,500 pounds.
- D. Valve box extensions shall be by the same manufacturer as the valve box.
- E. The plastic irrigation valve box cover shall be an overlapping type, one piece construction.
- F. Automatic control valve, master valve, flow sensor, and ball valve boxes shall be 17"x11"x12" 'nominal' rectangular size. Valve box covers shall be marked "RCV" with the valve identification number, or "MV-1" for master valve 1, "FS-1" for flow sensor 1, "BV" for ball valve "heat branded" onto the cover in 1-1/4 inch high letters / numbers.
- G. Drip flush valve and Air vacuum relief valve boxes shall be 6" circular size. Valve box covers shall be marked with "FV" for flush valve, "ARV" for air vacuum relief valve "heat branded" onto the cover in 1-1/4 inch high letters.

- H. Quick coupler valve boxes shall be 10" circular size. Valve box covers shall be marked with "QCV" "heat branded" onto the cover in 1-1/4 inch high letters.
- I. Pull boxes shall be 10" circular size. Valve box covers shall be marked with "PB" "heat branded" onto the cover in 1-1/4 inch high letters.
- J. Valve box cover shall be green in color and permanently marked (attached tags are not acceptable) on valve box cover plate with the words "Warning-Recycled Water-Do Not Drink".

2.17 LOW VOLTAGE CONTROL WIRING

- A. Remote control wire shall be direct-burial type, size as indicated on the drawings, and in no case smaller than 12 gauge.
- B. Remote control wire shall be 12 AWG solid core twisted pair, type as indicated on the irrigation drawings.
- C. Waterproof connections shall of the manufacturer, size, and type indicated on the drawings.
- D. Ground wires shall be green in color or bare copper and in no case smaller than 6 gauge.

2.18 IRRIGATION HEADS, DRIP EMITTERS AND INLINE DRIP TUBING

- A. Irrigation heads, drip emitters and inline drip tubing shall be of the manufacturer, size, type, with radius of throw, operating pressure, and discharge rate indicated on the drawings.
- B. Irrigation heads, drip emitters and inline drip tubing shall be used as indicated on the drawings.

2.19 DRIP IRRIGATION EQUIPMENT

Drip tubing equipment such as flush valves, air vacuum relief valves, filters and pressure regulators shall be of the manufacturer, size, and type indicated on the drawings.

2.21 MISCELLANEOUS EQUIPMENT

- A. Landscape Fabric:
 - 1. Landscape fabric for valve box assemblies shall be 5.0- oz. weight woven polypropylene weed barrier. Landscape fabric shall have a burst strength of 225

- PSI, a puncture strength of 60 lbs. and capable of water flow of 12 gallons per minute per square foot.
 - 2. Type: Mirafi 140N, DeWitt Pro 5 Weed Barrier or approved equal.
- B. Equipment such as flush valves, air relief valves, check valves, wye strainers, and master valves shall be of the manufacturer, size and type indicated on the drawings.

PART 3 - EXECUTION

3.11 SITE CONDITIONS

- A. Inspections:
- 1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 - 2. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- B. Discrepancies:
- 1. In the event of discrepancy, immediately notify the Landscape Architect or Owner's authorized representative.
 - 2. Do not proceed with installation in areas of discrepancy until all discrepancies have been resolved.
- C. Grades:
- 1. Before starting work, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths with respect to finish grade.
 - 2. Final grades shall be accepted by the Engineer before work on this section will be allowed to begin.
- D. Field Measurements:
- 1. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design. Contractor shall coordinate the installation of all irrigation materials with all other work.
 - 2. All scaled dimensions are approximate. The Contractor shall check and verify all size dimensions prior to proceeding with work under this section.
 - 3. 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.
- E. Diagrammatic Intent:

The drawings are essentially diagrammatic. The size and location of equipment and fixtures are drawn to scale where possible. Provide offsets in piping and changes in equipment locations as necessary to conform with structures and to avoid obstructions or conflicts with other work at no additional expense to Owner.

F. Layout:

1. Prior to installation, the Contractor shall stake out all pressure supply lines, routing and location of sprinkler heads, and valves.
2. Layout irrigation system and make minor adjustments required due to differences between site and drawings. Where piping is shown on drawings under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.

G. Water Supply:

Connections to, or the installation of, the water supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made at no additional expense to Owner.

H. Electrical Service:

1. Connections to the electrical supply shall be at the locations shown on the drawings. Minor changes caused by actual site conditions shall be made at no additional expense to Owner.
2. Contractor shall make electrical connections to the irrigation controller. Electrical power source to controller locations shall be provided by others. Contractor shall make Ethernet connection to the irrigation controller. Ethernet service to the controller location shall be provided by others per NEC codes. Ethernet service to include CAT-5 or CAT-6 cable in conduit from the nearest router to the controller with a maximum run of 328' including bends and twists.
3. Using the TCP/IP protocol, electrical contractor shall supply an Ethernet (RJ45) connector at the controller location, with the network set to have access to this connection. The Ethernet network must also be set by electrical contractor to assign a static IP address to the controller.

3.12 TRENCHING

- A. Excavations shall be straight with vertical sides, even grade, and support pipe continuously on bottom of trench. Trenching excavation shall follow layout indicated on drawings to the depths below finished grade and as noted. Where lines occur under paved area, these dimensions shall be considered below subgrade.
- B. Provide minimum cover of 18 inches on pressure supply lines 2 ½ inches and smaller.
- C. Provide minimum cover of 18 inches for control wires within planters.

- D. Provide minimum cover of 24 inches for control wires within sleeves below paving.
- E. Provide minimum cover of 36 inches on pressure supply lines under vehicular travel ways.
- F. Provide minimum cover of 12 inches for non-pressure lines.
- G. Pipes installed in a common trench shall have a 4-inch minimum space between pipes.
- H. Driplines in shrub and groundcover areas shall be installed with cover according to finished grade of soil. Provide a specified depth of cover over driplines with approved mulch.

3.13 THRUST BLOCKS

- A. Thrust blocks must be constructed of Class "B" concrete.
- B. Thrust blocks shall be poured against undisturbed site soil.
- C. PVC fitting joints shall be kept free of concrete. Do not encase fitting in concrete.
- D. Thrust blocking shall be sized to provide the minimum bearing areas as shown below. Bearing areas indicated have been calculated for Class 200 PVC pipe at a test pressure of 150 PSI in soil with 2,000 PSI bearing capacity. Increase thrust block sizing as necessary for varying soil conditions.
 - 1. Provide a minimum thrust block bearing area of 2.0 square feet on all bends (all degrees) and tees installed on pressure supply lines 4 inches and smaller.

3.14 BACKFILLING

- A. Backfill material on all lines shall be the same as adjacent soil free of debris, litter, and rocks over 1/2 inches in diameter.
- B. Backfill shall be tamped in 4-inch layers under the pipe and uniformly on both sides for the full width of the trench and the full length of the pipe. Backfill materials shall be sufficiently damp to permit thorough compaction, free of voids. Backfill shall be compacted to dry density equal to adjacent undisturbed soil and shall conform to adjacent grades.
- C. Flooding in lieu of tamping is not allowed.
- D. Under no circumstances shall truck wheels be used to compact backfill.

- E. Provide sand backfill a minimum of 4 inches over and under all piping under paved areas.

3.15 PIPING

- A. Piping under existing pavement may be installed by jacking, boring, or hydraulic driving. No hydraulic driving is permitted under asphalt pavement.
- B. Cutting or breaking of existing pavement is not permitted.
- C. Carefully inspect all pipe and fittings before installation, removing dirt, scale, burrs, and reaming. Install pipe with all markings up for visual inspection and verification.
- D. Remove all dented and damaged pipe sections.
- E. All lines shall have a minimum clearance of 4 inches from each other and 12 inches from lines of other trades.
- F. Parallel lines shall not be installed directly over each other.
- G. In solvent welding, use only the specified primer and solvent cement and make all joints in strict accordance with the manufacturer's recommended methods including wiping all excess solvent from each weld. Allow solvent welds at least 15 minutes setup time before moving or handling and 24 hours curing time before filling.
- H. PVC pipe shall be installed in a manner, which will provide for expansion and contraction as recommended by the pipe manufacturer.
- I. Center load all plastic pipe prior to pressure testing.
- J. All threaded plastic-to-plastic connections shall be assembled using Teflon tape or Teflon paste.
- K. For plastic-to-metal connections, work the metal connections first. Use a non-hardening pipe dope on all threaded plastic-to-metal connections, except where noted otherwise. All plastic-to-metal connections shall be made with plastic female adapters.

3.16 CONTROL WIRING

- A. Low voltage control wiring shall occupy the same trench and shall be installed along the same route as the pressure supply lines whenever possible.

- B. Where more than one wire is placed in a trench, the wiring shall be taped together in a bundle at intervals of 10 feet. Bundle shall be secured to the mainline with tape at intervals of 20 feet.
- C. All connections shall be of an approved type and shall occur in a valve box. Provide an 18-inch service loop at each connection.
- D. An expansion loop of 12 inches shall be provided at each wire connection and/or directional change, and one of 24 inches shall be provided at each remote control valve.
- E. A continuous run of wire shall be used between a controller and each remote control valve. Under no circumstances shall splices be used without prior approval.

3.17 VALVES

- A. Automatic control valves, quick coupler, and ball valves are to be installed in the approximate locations indicated on the drawings.
- B. Valve shall be installed in shrub areas whenever possible.
- C. Install all valves as indicated in the detail drawings.
- D. Valves to be installed in valve boxes shall be installed one valve per box.
- E. Provide valve ID tags for each remote control valve with valve number.

3.18 VALVE BOXES

- A. Valve boxes shall be installed in shrub areas whenever possible.
- B. Each valve box shall be installed on a foundation of 3/4 inch gravel backfill, 3 cubic feet minimum. Valve boxes shall be installed with their tops 1/2 inch above the surface of surrounding finish grade in lawn areas and 2 inches above finish grade in ground cover areas.

3.19 IRRIGATION HEADS

- A. Irrigation heads shall be installed as indicated on the drawings.
- B. Spacing of heads shall not exceed maximum indicated on the drawings, never greater than the manufacturer's rated distance of throw at operating pressure indicated.
- C. Riser nipples shall be of the same size as the riser opening in the sprinkler body.

3.20 DRIP EMITTERS AND INLINE DRIP TUBING

- A. Irrigation heads, drip emitters and inline drip tubing shall be installed as indicated on the drawings.
- B. Spacing of heads and inline drip tubing shall not exceed maximum indicated on the drawings.
- C. Hard PVC pipe laterals with fittings and risers, remote control valves, drip filters, ball valves and pressure regulators shall first be installed. Next, contractor shall flush out system thoroughly. Following flushing, contractor shall install all supply tubing and end flush caps/valves, and flush the lines once more. Any single-exit drip emitters shall then be installed. Flush again.
- D. Lay rolled out tubing in flat area to encourage tubing to relax from its stored form. Distribution tubing shall be cut into lengths that will allow tubing to lay in a relaxed manner from connection to connection as shown in the detail drawings. Tubing shall be given a generous amount of slack to allow for some movement. Use stakes as required to secure tubing. Provide consistent 4" cover over tubing.
- E. Special precautions:
 - 1. Distance from edges: allow not more than 6 inches from the edges, particularly if it is the top edge of a slope. Edges tend to dry more easily than the center. Remember that at the bottom of a slope the distance from the edges may be larger. (see also plans).
 - 2. Be aware of high points and siphoning: a potential problem with buried drip lines is siphoning dirt in when the system is switched off. For this reason:
 - A. Drip lines should have a fairly constant slope.
 - B. A vacuum relief valve should be provided at the highest point in each sector.
 - C. Drip lines should be connected at the end to a common flush line with a flush valve/vacuum breaker.
 - 3. Be aware of excessive level differences: level differences between drip lines belonging to the same valve should not exceed 6 to 8 feet.

4. Slopes: the steeper the slope, the better the horizontal movement of water in the soil. For this reason concentrate the density of the drip lines towards the top of the slope. At the bottom of the long gentle slope, the distance of the last dripper line from the edge should be wider spaced than the uphill runs, as water moves down due to gravity.
5. Positioning of air/vacuum relief valves: ensure that these valves are at a point high enough to prevent the system from draining through these valves when the water pressure is switched off.

F. System installation guidelines:

1. It is recommended that all areas to receive subsurface irrigation shall be first excavated to a level 5 inches below proposed level of finish grade.
2. Prepare the topsoil/backfill at adjacent location to planting area to get the best water saving results with the system. For new installations, it is recommended to follow the preparation procedures described above under "special precautions". Remember that excavation and grading should have been finished before installation of the subsurface drip system.
3. Be sure to have everything required for the installation before opening trenches. Do a dry runoff assembling without gluing the system parts on top of the ground first. Pre-assemble as many sets of components as practical above ground and in a convertible place. It is much easier to work above ground, so get as much work done as practical. Compression adapters should be glued to PVC tees/ells.
4. Always condition soil moisture the day before opening trenches or installing drip lines. Remember it is much easier to install the system in moist soil.
5. Install the system head first. Remote control valve, filters, pressure regulator and ball valve. Then install the PVC lateral lines.
6. Flush the lateral line outside the planter if practical. Connect to drip lines.
7. Distribute drip lines uniformly and as plans specify. Tubing stakes shall be installed on the tubing at the spacing of one per loop, or one every 10 linear feet. Contractor shall also mound small amounts of backfill over tubing at intervals to set tubing.

- a. Select the tentative distance between drip lines. (say d inches)
 - b. Measure the exact dimension of the area to be covered leaving 6 inches for the edges. (say l inches)
 - c. See how many spacings can actually be left. (l/d approximated to the nearest integer, say n)
 - d. Recalculate what the new revised distance between drip lines should be to divide the space evenly.
 - e. Stake where the beginning and flush end of each drip line will go.
8. Tubing installation: leave enough length at the beginning and end for connections. It is convenient to finish the last foot of the installation or trench by hand. This gives more room for connections. Beware of bending the drip tubing too tight during installation. Do not bend tubing below a 24 inch radius because the pipe may kink, reducing the flow. Use compression type elbows and fittings whenever required. Use large bucket for forming bends or for spacing lines as required to keep lines uniformly spaced.
 9. The systems shall be left open and tubing and emitters left uncovered for testing purposes by the landscape architect. After successful testing of systems, cover system with prepared backfill previously set aside. Cover tubing early in the morning when temperatures are low to avoid tubing stress.
 10. Warning: drip line is temperature sensitive. The protective life of the system will be reduced if the drip line outside is exposed to the sun for a long period of time. Store the drip line in a cool shaded place until installed.

4.21 Miscellaneous Equipment

- A. Install all assemblies specified herein according to the respective detail drawings or specifications, using best standard practices.
- B. Quick coupler valves shall be set approximately 18 inches from walks, curbs, header boards, or paved areas where applicable.

- C. Install devices such as flush valves, air relief valves, pressure regulators, master valves and flow sensors as indicated on the drawings and as recommended by the manufacturer.

3.23 FLUSHING THE SYSTEM

- A. Prior to installation of irrigation heads, the valves shall be opened and a full head of water used to flush out the lines and risers.
- B. Irrigation heads shall be installed after flushing the system has been completed.

3.24 ADJUSTING THE SYSTEM

- A. Contractor shall adjust valves, adjust drip emitters and driplines, align heads, and check the coverage of each system prior to coverage test.
- B. If it is determined by the Landscape Architect or Owner's authorized representative that additional adjustments or nozzle changes will be required to provide proper coverage, all necessary changes or adjustments shall be made prior to any planting.
- C. The entire system shall be operating properly before any planting operations commence.
- D. Automatic control valves are to be adjusted so that the irrigation heads, drip emitters and inline drip tubing operate at the pressure recommended by the manufacturer.

3.25 TESTING AND OBSERVATION

- A. Do not allow or cause any of the work of this section to be covered up or enclosed until it has been observed, tested and accepted by the Landscape Architect, Owner, and governing agencies.
- B. The Contractor shall be solely responsible for notifying the Landscape Architect, Owner, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing.
- C. When the sprinkler system is completed, the Contractor shall perform a coverage test of each system in its entirety to determine if the water coverage for the planted areas is complete and adequate in the presence of the Landscape Architect.
- D. The Contractor shall furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from the plans, or where the system has been willfully installed as indicated on the drawings when it is obviously inadequate,

without bringing this to the attention of the Landscape Architect. This test shall be accepted by the Landscape Architect and accomplished before starting any planting.

- E. Areas to be maintained for the formal maintenance period shall start maintenance at the same time, as directed by the Landscape Architect, Owner, and governing agencies. Partial areas will not be released into maintenance prior to completion of items listed in the pre-maintenance review. The maintenance period may not be phased.
- F. If, after the maintenance review, the irrigation systems are not accepted by the Landscape Architect, the contractor shall reimburse the Architect for additional site visits, or additional time required to review work. All additional time will be billed at the Architect's hourly rate and will be paid for by the contractor at no additional cost to the owner.
- G. Final inspection will not commence without record drawings as prepared by the Irrigation Contractor.

3.26 MAINTENANCE

During the maintenance period the Contractor shall adjust and maintain the irrigation system in a fully operational condition providing complete irrigation coverage to all intended plantings.

3.27 COMPLETION CLEANING

Clean up shall be made as each portion of the work progresses. Refuse and excess dirt shall be removed from the site, all walks and paving shall be swept, and any damage sustained on the work of others shall be repaired to original conditions.

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SECTION 32 90 00 - LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes materials, soil preparation, planting, staking, and cleanup.
- B. Definitions:
 - 1. Architect: the Landscape Architect or the Owner's authorized representative.
 - 2. Soil Test: Required testing performed by Contractor after site is rough graded. A current soil report is also required for import soil prior to transport to the site.
 - 3. Punch List: List of work within the Contract, generated by Architect that needs to be completed, repaired, replaced, or rectified by Contractor.
 - 4. Pre-maintenance review: Observation by Architect to verify substantial completion of the Work. The Architect will generate a Punch List during this review. Maintenance Period will commence when Contractor has completed items on this Punch List and Architect has verified that the Punch List is complete.
 - 5. Maintenance Period: See Specification section 320190.
 - 6. Final Acceptance: Observation review by Architect at end of the specified Maintenance Period to verify completion and acceptance of the Work.

1.2 QUALITY ASSURANCE

- A. Standards:
 - 1. Provide plants and planting materials that meet or exceed specifications of Federal, State, and County laws requiring inspection for plant disease or insect control.
 - 2. Provide quality and size conforming to current edition of "Horticultural Standards" for number one nursery stock as adopted by the American Association of Nurserymen.
 - 3. 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 of the American Association of Nurserymen.
 - 4. Botanical names shall take precedence over common names.
- B. Workmanship: Perform work in accordance with the best standards of practice for landscape work and under the continual supervision of a competent foreman capable of interpreting the Drawings and Specifications.
- C. Quantities and Types: Plant materials shall be furnished in the quantities and/or spacings as shown or noted for each location, and shall be of the species, kinds, sizes, etc., as symbolized and/or described in the Plant List, and as indicated on the Drawings.
- D. Verification of dimensions, quantities, and existing conditions

1. Scaled dimensions are approximate. Before proceeding with work, carefully check and verify dimensions and quantities and immediately inform the Architect of discrepancies between the Drawings and/or specifications and actual conditions. Do not start work in areas where there are discrepancies until approval for same has been given by the Architect.
2. Prior to the excavation for planting or placing of plant materials, the Contractor shall verify the location of all underground utility lines and other improvements and take proper precautions to avoid damage to such improvements. In the event of conflict between such improvements and plant locations, the Contractor shall notify the Architect and arrangements will be made for relocation as necessary. Failure to follow the procedure places upon the Contractor the responsibility for making any and all repairs for damage resulting from work as herein specifies at his own expense.

1.3 SUBMITTALS

- A. Submit documentation to Architect 60 days before start of planting that plant material is available. Include:
 1. A list of plants stating quantity, size, and supplier.
 - 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.
 2. Photographs of trees 24" box and larger.
 - a. Label each photo with plant name, plant height, spread and trunk caliper.
 - b. Label each photo with nursery name, nursery contact and phone number.
 - c. Photograph shall include a person in picture for scale purposes.
- B. Soil Test: Contractor shall have import soil and the soil of the site tested for fertility, agricultural suitability, and appraisal by Soil and Plant Laboratory Inc. (714) 282-8777, or Wallace Labs (310) 615-0116.
 1. Submit a copy of the Planting Plan and Plant Legend to the laboratory with the samples.
 2. Soil report shall include:
 - a. pH measurement.
 - b. Nutrients and elements:
 - 1) Measurement (low, medium, high) of: Boron, calcium, copper, iron, magnesium, manganese, molybdenum, phosphorus, potassium, sodium, sulfur, and zinc.
 - 2) Analyze saturation extract for: calcium, magnesium, sodium, boron, chloride, phosphorus, nitrate and sulfate.
 - 3) Trace metals: Aluminum, arsenic, cadmium, chromium, cobalt, lead, lithium, nickel, selenium, silver, strontium, tin and vanadium.
 - 4) The presence of calcium carbonate and/or magnesium carbonate.
 - c. Soil Texture (gravel, sand, silt and clay). Determine organic matter content by the measurement of organic carbon. The quality of the organic matter shall be determined by measuring organic carbon and total nitrogen.
 - 1) Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods, Soil Science Society of America, Inc., 1986, chapter 36, pgs 901-926 and

Methods of Soil Analysis, Part 3 Chemical Methods, Soil Science Society of America, Inc, 1996, chapter 34, pgs 965-977 & pgs 1001-2 and chapter 37, pg 1088

- d. Interpretation and recommendations for correction of nutritional deficiencies/ excesses and potential toxicities.
 3. Soil shall be tested from a minimum of four (4) locations per acre of planted area. Contractor shall record locations where samples were taken.
 4. A copy of the soil test results shall be submitted to the Owner and Architect before work begins.
 5. Contractor shall pay cost of all soil tests.
- C. Cut sheets of materials to be used:
1. Tree stakes
 2. Root barriers
 3. Amendments
 4. Mycorrhizal fungi
- D. Legible copies of delivery slips for soil amendments, including mycorrhizal fungi.
- E. The Contractor shall submit samples or specifications of items being used upon the request of the Architect, and as required by this Part 2 of this Specification.
- F. Samples for verification for each of the following:
1. Bark Much- 1 quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of with and source of mulch. Each sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 2. Bio-retention soil- 1 quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials including the following:
 - a. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.
 - b. Grain size analysis of the mineral aggregate component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
 - c. Quality analysis results for compost performed in accordance with the US composting Council Seal of Testing Assurance (STA) standards.
 - d. Grain size analysis of the compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
 3. Top Soil- 1 quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials.

1.4 OBSERVATION SCHEDULE

- A. Contractor shall be responsible for notifying the Architect, in advance, for the following observations, according to the time indicated:
1. Pre-construction conference – seven (7) days
 2. Layout of Tree Materials (trees 24" box size and larger) – 48 hours
 3. Final grade, soil preparation and planting area layout review - 72 hours
 4. Plant materials review - 48 hours

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5. Plant layout review - 48 hours
 6. Planting operations - 48 hours
 7. Completed planting (Pre-maintenance) walk through – seven (7) days
 8. Final Site Observation and Acceptance of the Project – seven (7) days
- B. Contractor shall be responsible for scheduling site Observation visits with Architect as work progresses. Failure to schedule required Observations shall not relieve Contractor of responsibility for obtaining approvals. Contractor shall redo, at no cost to the Owner, work that does not satisfy the Owner.
- C. Observations may be waived or combined at the discretion of the Architect.
- D. When someone other than the Architect conducts Observations, the Contractor shall show evidence in writing of when and by whom these observations were made.
- E. No site visits shall commence without adequate preparation or items noted in previous Observation Reports, either completed or remedied, unless the Owner has waived such compliance. Failure to adequately prepare or accomplish previous punch list items shall make the Contractor responsible for reimbursing the Architect for the site visit at his current billing rates per hour plus transportation costs. No further inspections will be scheduled until this charge has been paid and received.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer or soil amendments to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trademark, and conformance to state law. Protect material from damage or breakage. Immediately remove empty containers from site. The contractor shall furnish the Architect with a copy of signed, legible certificates or invoices stating the quality and quantity of all items herein specified at the time of delivery.
- B. Deliver plants with legible identification labels. Store plant material in shade and protect from weather or injury. Maintain in a healthy, vigorous condition. Architect may at time reject plant material not maintained in this condition.
- C. Handling: Do not drop plants or pick up container plants by their stems or trunks.

1.6 SAMPLES AND TESTS:

- A. Contractor shall submit soil samples for testing, per this Specification.
- B. Architect reserves the right to take and analyze samples of materials for conformity to specifications at any time. Contractor shall furnish samples upon request by Architect.
- C. Rejected materials shall be immediately removed from the site at the Contractor's expense.
- D. Contractor shall pay cost of all testing or replacement of materials not meeting specifications.

1.7 WARRANTY AND REPLACEMENT

- A. Contractor shall fully warrant and agree to replace poor, inadequate, or defective materials and workmanship for one year from date of acceptance of completed planting work.
- B. Replacement: Materials found to be dead, missing, or in poor condition during the establishment period shall be replaced immediately. The Architect shall be the sole judge as to the condition of material. Material to be replaced during the warranty period shall be replaced by the Contractor within fifteen days of written notification by Owner.

PART 2 - PRODUCTS

2.1 SOIL

- A. Site Soil:
 - 1. Site soil used to form landscape planting areas or backfill planters shall be clean, fertile, loamy soil, free of stones, sticks, stumps, or other deleterious matter one inch in diameter or larger. It shall also be free from wire, plaster, construction debris, or similar objects that would be a hindrance to planting or maintenance.
 - 2. The Architect shall approve suitability of soil of the site after reviewing results of the soil test.
- B. Import Top Soil: Clean, fertile, sandy loam soil, free of stones or other deleterious matter one inch in diameter or larger. It shall also be free of pockets of coarse sand, noxious weeds, sticks, lumber, brush and other litter. It shall not be infested with nematodes or other undesirable disease-causing organisms such as insects and plant pathogens. Import top soil must conform to the following:

- 1. Particle size

<u>Class</u>	<u>Particle Size Range</u>	<u>Maximum %</u>	<u>Minimum %</u>
Coarse sand	0.5 - 2.0mm	15	0
Silt plus clay	<0.05mm	50	15
<u>Other classes:</u>			
Gravel	2-13mm	15	0
Rock	1/2 - 1"	5% by volume with none > 1"	

- 2. Chemistry
 - 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. Reaction: pH of Saturated Paste - 5.5-7.8 without high lime content
- 3. Soil shall contain sufficient quantities of available nitrogen, phosphorus, potassium, calcium and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required material prior to planting.

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4. In order to insure conformance, samples of the import soil shall be submitted to an approved laboratory for analysis prior to and following backfilling.
5. Obtain imported topsoil from approved local sources.

C. Backfill for at grade trees and shrubs shall be per Soils Report.

2.2 SOIL AMENDMENTS

- A. Soil amendments shall be as required by Soils Test
- B. Contractor shall provide amendments recommended by Soils Report at no additional cost to Owner, including recommendations for the quality of organic amendment.
- C. Mycorrhizal fungi shall be added in all planting areas, regardless of Soils Report. Mycorrhizal inoculum consists of a combination of :
 1. Inoculum shall contain 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*, and seven top types of Ecto fungi spores: *Laccaria laccata*, *Pisolithus tinctorius*, *Rhizopogon amylopogon*, *R. fulvigleba*, *R. rubescens*, *R. villosuli*, and *Scleroderma* spp. The guaranteed Endo spore count shall be a minimum 50 spores/cc, and 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. Or equal.

2.3 PLANT TABLETS

- A. 7 gram planting tablet designed for 12 month slow release. 12-8-8 NPK, 20% humus, 4% humic acids, 3.5% sulfur, 2% iron, micronutrients.

2.4 PLANT MATERIAL

- A. 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.
- B. The size of the plants will correspond with that normally expected for species and variety of commercially available nursery stock or as specified on Drawings.
- C. The Architect shall approve plant material prior to planting. Plants shall be subject to review and approval of Architect at place of growth or upon delivery for conformity to specifications, and for injury, insect infestation, and trees and shrubs for improper pruning. Such approval shall not impair the right of review and rejection during

progress of the work. Architect reserves the right to refuse review if, in his/her judgment, a sufficient quantity of plants is not available for review.

- D. Plants not conforming to the requirements herein specified shall be considered defective, and such plants, whether in place or not, shall be marked as rejected and immediately removed from the site and replaced with new plants at the Contractor's expense.
- E. Plant material shall be true to botanical and common name and variety as specified in "Sunset Western Garden Book."
- F. Substitute plant material will not be permitted unless specifically approved in writing by the Architect.
- G. Labeling: Each group of plant materials delivered on site shall be clearly labeled as to species and variety. However, final determination of plant species and variety will be made by the Landscape Architect and whose decision will be final. All patented plants (cultivars) required by the plant list shall be delivered with a proper plant patent label attached.
- H. Pruning: At no time shall the plant materials be pruned, trimmed, or topped prior to delivery and any alteration on the site of their shape shall be conducted only with the approval and in the presence of the Landscape Architect.

2.5 GUYING AND STAKING MATERIALS:

- A. Wood tree stakes: Lodgepole pine, fully treated with CuNap, ACQ or other non-arsenic wood preservative. Do not use split stakes.
 - 1. 24" box trees and smaller: 2" (nom.) diameter by 10' long.
 - 2. 36" box trees: 3" (nom.) diameter by 12' long.
- B. Tree Ties:
 - 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. Manufacturers: VIT Cinch Tie, VIT Cinch Belt (larger trees), Villa Root Barrier E-Z Band, or equal.

2.6 WATER:

- A. Furnished by Owner.
- B. Transport by Contractor as required.

2.7 MULCH:

- A. Decorative Bark:
 - 1. Walk-On-Bark as supplied by Sequoia Forest Products, telephone: (559) 591-1177, or approved equal.

2. No shredded lumber products will be accepted.
3. Shall be derived from bark or pine, white fir and/or red fir

2.8 DRAINAGE MATERIAL - 3/8" CRUSHED ROCK:
 95% -100% passing through a 3/8" screen.
 0-5% passing through No. 8 mesh.
 80-100# per cubic yard.

2.9 SOIL SEPARATOR:

- A. Nonwoven polypropylene fabric, needle-punched, with UV Resistance of 70%, AOS of 70 US Standard sieve, water flow rate of 110 gpm/ft².
 1. Geotex 701, manufactured by Propex, or equal.

2.10 EROSION CONTROL FABRICS

A. Jute mesh.

1. <u>Specification</u>	<u>Test Method</u>	<u>Typical Values</u>
a. Yarn Fiber	Woven	jute, undyed and unbleached
b. Yarn Count, Warp		78 per width, minimum
c. Yarn Count, Weft		42 per linear yard, minimum
d. Color		Natural(Brown, Earth Tone)
e. Fabric Width (in)		48
f. Fabric Weight (lb/yd ²)		92
g. Strands/ft, Warp		19.5
h. Strands/ft, Weft		14.0
i. Mass/Unit Area (oz/yd ²)		14.7
j. Wide Width Tensile, Dry (lb/ft)		
Warp x Fill	ASTM D 4595	..300 x 175
k. Wide Width Tensile, Wet (lb/ft)		
Warp x Fill	ASTM D 4595	..125 x 65
l. Elongation at Break (%)		10 x 10
m. Open Area (%)		60 - 65
n. Durability(yr)		1 - 2
o. Water Velocity (ft/sec)		8
p. Unit Shear Test (lb/ft ²)		0.45
q. "C" Factor, 1.5:1 slope		0.005

2.11 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.
- B. 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

2.12 ROOT BARRIER

- A. Polyethylene (0.08 inch thick) or polypropylene (2.032 - 2.16 mm thick), with self-locking joiners, 1/2" raised 90 degree molded root deflecting ribs, ground lock tabs, double top edge, UV inhibitors. Use 24" barrier unless otherwise stated.

2.13 DRAIN PIPE:

- 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 gravel, unless otherwise noted on Plans.
- B. Planter Area Drainpipe and Fixtures: National Diversified Sales (NDS) SDR 35 fittings and SDR 35 drain pipes with specified grates, color black, and size and type per Plans. NDS, Newbury Park, California, telephone: (800) 726-1994.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION:

- A. Site acceptance:
 1. The Contractor shall be responsible for coordinating his work with the General Contractor and other Sub-Contractors so no damage occurs to plantings after installation.
 2. The Contractor shall be responsible for verifying grades and site conditions before beginning work. No change in Contract price will be owed for actual or claimed discrepancy between existing grade and those shown on the plan after Contractor has accepted existing grades and moved on the site.
- B. Scheduling: Perform planting only when weather and soil conditions are suitable, as approved by Architect.
- C. The irrigation system shall be operational and approved prior to planting.
- D. Utilities: Prior to excavation for planting or installation of stakes or guys, Contractor shall locate utility lines and cables, so that proper precautions will be taken not to damage them. In the event of a conflict between utility lines and plant locations, promptly notify the Architect, who shall arrange for the relocation of one or the other. Failure to follow this procedure shall make the Contractor responsible for repairing damages at his own expense.

- E. Waterproofing: Verify that waterproofing is complete and water-tight in over-structure planters.

3.2 SOIL PREPARATION:

- A. Planting Areas:
 - 1. Uniformly spread amendments and thoroughly cultivate by means of mechanical tiller per Soils Report.
 - 2. Use nutrients recommended in the Soil Report.
 - 3. Add the appropriate Mycorrhizal inoculum and incorporate at manufacturer's recommended rate.
 - 4. Perform soil preparation after irrigation is installed and tested, and prior to planting.

- B. Final Grades and Planting Area Layout:
 - 1. At time of planting, the top two (2) inches of areas to be planted or seeded shall be free of stones, sticks, stumps, or other deleterious matter one inch in diameter or larger. It shall also be free from wire, plaster, construction debris, or similar objects that would be a hindrance to planting or maintenance.
 - 2. Contractor shall be responsible for shaping planting areas as indicated on Plans or as directed by Architect.
 - 3. Minor modifications to grade may be required to establish the final grade. Remove soil generated by excavations to an approved off-site location unless said soil can be utilized to obtain desired grade.
 - 4. Finish grading shall insure proper drainage of the site as determined by the Architect.
 - 5. Areas shall be graded so that the final grades will be 1-1/2" below adjacent paved areas, sidewalks, valve boxes, headers, cleanouts, drains, manholes, etc. or as indicated on Plans.
 - 6. Surface drainage shall be away from building foundations.
 - 7. Eliminate erosion scars prior to commencing maintenance period. Depressions due to settling shall be eliminated before and after planting.
 - 8. Slopes of two to one (2:1) or steeper shall be protected with erosion control fabric. Contractor shall request clarification from Architect for fabric and methods.

- C. Compacted Soil / Percolation Testing:
 - 1. Planter areas: Soil may be heavily compacted which can hinder root development, drainage and aeration.
 - a. Severely compacted areas shall be ripped or tilled to a depth of at least 9" prior to planting.
 - b. Percolation tests of water through the soil shall be performed where trees 24" box size and larger are proposed. If trees are to be planted over a large area, several percolation tests will be required.
 - 1) Excavate two planting pits 24" deep by 2 times rootball diameter. Install sand filled drainage sump as specified in 3.3.D.4, below, in one of the pits.
 - 2) Fill the pits with water and allow to drain completely.
 - 3) Fill the pits with water a second time.

- 4) Results:
 - a) If the pit with no sump drains completely within 24 hours, no drain sump is necessary for trees planted within the vicinity of the test pit.
 - b) If the pit with no sump does not drain completely within 24 hours, but the pit with the sump does, sumps are required for trees planted in the vicinity of the test pit.
 - c) If the pit with the sump does not drain completely within 24 hours, advise the Owner prior to planting.

D. Pre-Plant weed Control:

1. "Grow & Kill": If weeds exist on site at the beginning of work, spray with a non-selective systemic contact herbicide, recommended by an approved licensed landscape Pest Control Advisor and applied by a licensed Pest Control Operator. Leave sprayed plants intact to allow systemic kill as directed by Advisor. After recommended kill period, water thoroughly to encourage new weed growth, and re-apply systemic herbicide.
2. Treat planting areas, except for those to be seeded, with pre-emergent herbicide, recommended by an approved licensed landscape Pest Control Advisor and applied by a licensed Pest Control Operator
3. Maintain site weed free until final acceptance by Owner by utilizing mechanical, manual, or chemical treatment.

E. Slope Stabilization

1. Slopes greater than 3:1 are to be stabilized with jute mesh.
2. Prepare soil as noted above.
3. Unroll jute from top of slope to bottom. Secure at top of slope by toeing jute in 6" deep. Reinforce with a row of at least five staples, spacing each about a foot apart, and covering with soil.
4. Place staples 18" to 24" apart throughout to secure matting to ground. Staples must be driven flush with soil surface.
5. Overlap edges of rolls 6", minimum. Securely staple the two layers to the ground.
6. Install jute mesh loosely - do not stretch.
7. Check slots may be needed on steep slopes to prevent subsurface erosion.
 - a. Dig 6" deep trench perpendicular to water flow.
 - b. Drop two or three folds of fabric in the slot.
 - c. Staple fabric securely in bottom of trench, and continue rolling down hill.
8. Use approximately 200 staples per 100 square yards of fabric.

3.3 PLANTING

- A. Planting Layout: Plant layout is to be approved by Architect before planting begins. Layout of trees and major plantings shall be approved first. One tree with each type of specified staking shall be approved prior to planting of trees. Bring conflicts regarding the exact locations of plant pits to the attention of Owner's representative and Architect. If underground utility lines or other unknowns are encountered in excavation for planting, alternate locations for planting may be selected by the Architect. It is the Contractor's responsibility to verify with the Owner's superintendent and governing agencies the location and depth of underground utilities.

- B. Planting of Trees and Shrubs (at grade):
1. Do not plant rootbound, dried out, undersized, or damaged plants.
 2. Excavated holes shall have vertical sides with roughened surfaces and shall be twice the diameter and the depth of the root ball.
 3. Drainage: Drainage sumps are to be provided in each tree pit. Drain sumps (12-inch diameter by 6 feet deep) may be augured. Sump is to be filled with coarse sand. Planting may proceed after sump installation.
 4. Fill excavations with water and allow to percolate out, before positioning trees and shrubs.
 5. Install root control barriers where indicated on Plans and where site conditions (trees within three feet of pavement) dictate. Install per manufacturer's instructions.
 6. Center plant in pit or trench. Remove boxes and cans without damage to rootball. Add the appropriate Mycorrhizal inoculum next to rootball at manufacturer's recommended rate. Set plant plumb and hold rigidly in position until soil has been dampened firmly around b or roots. An earthen basin shall be constructed around each plant. Each basin shall be of a depth sufficient to hold at least two inches (2") of water. Remove basin in turf areas after initial watering. Plants that settle deeper than the surrounding grade shall be raised to surrounding grade level.
- C. Planting Tablets: Place the following numbers of 7-gram planting tablets within the backfill of each plant:
- | Container size / Number of tablets | |
|------------------------------------|----|
| 1 gallon | 3 |
| 5 gallon | 8 |
| 15 gallon | 12 |
| 24" box | 16 |
| 36" box | 24 |
| 48" box | 32 |
- D. Staking: Staking of trees shall be completed immediately upon planting. Stakes shall be installed plumb and as indicated in details. Bring conflicts of locating stakes to the attention of Architect. Remove nursery stakes when site stakes have been installed.
- E. Ground covers: Ground covers or seedlings shall be planted in straight rows and evenly spaced, unless otherwise noted, and at intervals called out in the drawing. Triangular spacing shall be used unless otherwise noted on the drawing. Fill in bare areas with plants at the required spacing. Damage to plants by trampling or other work in this contract shall be repaired immediately.
- F. Mulch covers:
1. Complete planting and finish grades before placing mulch.
 2. Place mulch material in a continuous layer 3" deep adjacent to plant crown in shrub and groundcover areas, and in areas between shrubs.
 3. Place mulch in a 2" deep layer in areas with flatted groundcover and annual color.
 4. Install special mulches (cobble) over weed control fabric.
 - a. Overlap fabric a minimum of 8".

3.4 CLEANUP

- A. After planting operations have been completed, remove trash, excess soil, empty plant containers, and rubbish from the property, and dispose of legally.
- B. Cleanup shall be performed at the end of each working day, with a maximum cleanup effort (in a manner satisfactory to the Owner) for each weekend or Holiday.
- C. The Contractor shall sweep the site and shall wash down pavement within the Contract area, leaving the premises in a clean condition.
- D. Walks shall be left in a clean and safe condition.
- E. Scars, ruts, or other marks in the ground caused by this work shall be repaired and the ground left in a smooth condition throughout the site.

END OF SECTION 32 90 00

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SECTION 32 96 00 - LANDSCAPE DEMO, TREE PROTECTION, TREE TRANSPLANTING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work covered under this section consists of all labor, equipment and materials necessary to adequately protect existing trees from damage due to construction activities through the establishment of Tree Protection Zones, erection of barricades; demolition of existing surface pavements, curbs, and structures; root pruning, watering, fertilizing, and transplanting of existing trees to be relocated on site; staking, guying and maintenance.
- B. Transplanting trees from job site, delivering to holding area, maintaining, irrigating and re-planting.
- C. Trees to be removed under direction of the Owner's Representative.

1.2 GENERAL REQUIREMENTS

- A. See Demolition Plans for Tree Protection Zones, trees to be removed, trees to be saved in their current locations and trees to be transplanted.
- B. The Contractor shall coordinate all work with other contractors working within the limits of work whether part of this contract or through separate contracts with the Owner.
- C. Labor crews shall be experienced in root pruning techniques, the protection and transplanting, care and maintenance of all trees to be saved and transplanted.
- D. Personnel responsible for the maintenance of all affected trees shall be approved by the Owner.

PART 2 - MATERIALS

2.1 GENERAL

- A. All chemicals used shall be approved by the owner prior to delivery to site.
- B. All chemicals and products shall be registered by the State of California Department of Food and Agriculture and the Environmental Protection Agency with registration identification on the label. Label shall be at job site at all times.
- C. All chemicals and products shall be applied as per registered label instruction and manufacturer's recommendations.
- D. Chemicals and products requiring a licensed applicator must be applied by persons registered with the Department of Agriculture's Commissioner's Office as possessing a current, valid, qualified pest control applicator's license and or state/local government agency.
- E. The use of any restricted materials is forbidden.

- F. All products shall be non selective, translocative and approved by owner prior to application.

2.2 TOPSOIL / PLANTING MIX

- A. Topsoil / Planting Mix backfill to be per Section 329000 Landscape Planting.

2.3 FERTILIZER

- A. Mix Design: Specific fertilizer chemical mix shall remedy nutrient deficiencies noted in the soils analysis per Section 329000 Landscape Planting. The Contractor shall provide a complete commercial fertilizer mixture complying with the laws of manufacture regulating the sale and manufacture of fertilizer in the State of California.
- B. Commercial fertilizer shall be per Section 329000 Landscape Planting.

2.4 DOLOMITIC LIMESTONE (IF NEEDED)

- A. Dolomitic limestone shall be a natural limestone, designated for agricultural use, shall contain not less than 85 percent of total carbonates, and shall be ground so that 50 percent will pass a 100 mesh sieve and 90 percent will pass a 20 mesh sieve.

2.5 PRE-EMERGENCE WEED CONTROL

- A. Weed control shall be Ronstar 2G as manufactured by Bayer Environmental Science, Canada, Telephone 888.283.6847, www.bayeres.ca, or an owner approved equal.

2.6 WATER

- A. Water will be available for use on site during the landscape installation at no cost to the Contractor. Care shall be exercised to assure that water is kept free of harmful chemicals, acids, alkalis, or any substance which might be harmful to plant growth. It is the Transplant Contractor's responsibility to connect irrigation lines, valves, heads, etc to water supply for irrigation of root pruned trees, palms, and shrub material in the holding area. Transplant Contractor is also responsible for temporary watering of transplanted trees in their final location prior to irrigation system being installed.

2.7 ANTIDESICCANT

- A. Antidesiccant shall be an emulsion type, film-forming agent designed to permit transpiration, but retard excessive loss of moisture from plants, such as Dowax by Dow Chemical Co., or Wilt-Pruf by Nursery Specialty Products, Inc., or an acceptable equal. The antidesiccant shall be delivered in the manufacturer's fully identified containers and shall be mixed in accordance with manufacturer's instructions.

2.8 VITAMIN

- A. Vitamin shall be 'Superthrive' or owner approved equal shall be applied to approved trees to be transplanted. Application shall be per manufacturer's recommendations.

2.9 BORICIDE (IF NEEDED)

- A. Boricide shall be Onyx manufactured by FMC Corporation, Memphis, TN USA, www.pestsolutions.fmc.com Telephone 800.321.1362, or 901.565.0301, or an approved equal.

2.10 ROOTING STIMULANT

- A. Mycorrhizal - per Section 329000 Landscape Planting.

2.11 PRUNING MATERIALS

- A. Pruning tool sterilant shall be Physan 20 Fertilome Type A, available from Maril Products, Tustin CA, USA, www.physan.com, Telephone 800.546.7711, or diluted bleach, or approved equal.

2.12 MULCH

- A. All mulch shall be per Section 329000 Landscape Planting.

2.13 GUYING AND STAKING MATERIAL

- A. Stakes for supporting trees shall be per Section 329000 Landscape Planting.

2.14 MECHANICAL EQUIPMENT AND MACHINERY

- A. All mechanical equipment, vehicles and machinery for the transplanting of trees shall be approved by the Owner prior to its use. All equipment used shall not be configured as to come in contact with tree trunks or their major branches or to damage the tree in any way.

2.15 SMALL HAND TOOLS

- A. All pruning shears, loppers, saws, blades, and other tree pruning equipment shall be new, clean, sharp, free from defects, cuts, rust, contamination or other deficiencies which may harm existing trees or prevent a clean sharp cut during pruning operations.

2.16 BARRICADES (TREE PROTECTION ZONES)

- A. Trees remaining in their current locations within the limits of construction area or adjacent to the construction area shall to be protected at all times from damage of their roots, trunk, limbs or foliage as noted on plans and details.

- B. Trees transplanted from site and stored in holding area shall not be exposed to damage by site construction work and shall be protected with a 4' high orange envirofence (open weave plastic).

PART 3 - EXECUTION

3.1 PREPARATION BEFORE TRANSPLANTING

- A. The Contractor shall verify that final grades have been established prior to beginning planting operations. All unsatisfactory grading shall be reported to the Owner, and the

Contractor shall not proceed with the work until the unsatisfactory conditions have been corrected. When conditions detrimental to plant growth are encountered, such as rubble, fill or adverse drainage conditions, the Contractor shall notify the Owner for directions.

- B. Should undesirable existing vegetation be present on the site at the time of root pruning, the Contractor shall remove vegetation as recommended by the Owner.
- C. Should undesirable existing vegetation be present on the site at the time of installation, the Contractor shall prepare the site for planting by use of chemicals, when used as recommended by the manufacturer, and/or mechanical means acceptable to the Owner.
- D. Care shall be exercised to avoid any misuse of chemicals which would create detrimental residual conditions. Care must also be used not to alter final grades which have been established or cause damage to previously established turf areas.

3.2 TREE ROOT PRUNING AND TRANSPLANTING

- A. The Contractor shall field identify all trees that are to be saved in their current locations and all trees to be root pruned/transplanted with color flagging tape for approval by Owner before any work is begun.
- B. Two months prior to transplanting, Contractor to apply 'Superthrive' to Owner approved trees to be transplanted. Application shall be per manufacturer's recommendations.
- C. The Contractor shall prune and thin out approximately 1/3 of the overhead canopy of all trees to be transplanted. This shall be executed no less than one month prior to transplanting. All cuts shall be clean and flush and shall be angled to prevent water ponding. Pruning operations shall not adversely affect the shape and character of the trees. Pruning shall remove lateral branches only. All main, primary and secondary branches shall not be removed.
- D. The Contractor shall install, erect and provide temporary overhead mist irrigation for all trees to be transplanted. This shall be executed no less than one month prior to transplanting. The mist irrigation shall be installed to thoroughly wet all foliage. Methods for irrigation timing shall be provided by the Contractor and shall be coordinated with the Owner so as not to interfere with normal operations. The mist irrigation system shall be timed to activate for 5 to 10 minutes at a time every 30 minutes between the hours of 10:30 a.m. and 5:30 p.m., 7 days a week. The temporary mist system shall be painted brown.
- E. Unless otherwise approved by the Owner, all root cuts shall be executed by hand methods only using clean, sharp tools. Mechanical equipment shall not be used.
- F. Where necessary, existing asphalt pavements, sub-base, curbs, walks, irrigation, or other structures shall be demolished and removed by the Contractor before transplanting. All demolished material shall be removed from the site and legally disposed of by the Contractor at no additional charge to the Owner. Where demolition occurs under the drip line of any tree to be transplanted, this demolition shall be accomplished by hand

methods or approved small hand held mechanical equipment. Large machinery may be used so long as the machinery is kept outside the drip line of the tree.

- G. The Contractor shall delineate the maximum rootball size allowing 10" for each 1" trunk diameter. Excavate 2' wide trench to 2' depth more or less (by hand). Sever peripheral roots with sharp saw. Reduce rootball size to point of encountering major roots (greater than 2" in diameter) and/or high concentration of fibrous roots. Undercut rootball at depth of 2' or zone where root density decreases significantly. Wire ball and double layer of burlap. Backfill with sawdust. Allow acclimatization period of four to six weeks. Trees to be drilled and "pinned" at various diameters depending on size. After transplanting, pins will be replaced with wooden dowels. Each tree will receive two (2) GEL TEK applications: one prior to digging and one following transplanting. Trees 8" caliper or less may be transplanted using mechanical tree spades. The size of the tree spade shall not be less than 90" in diameter. The Contractor shall handle all trees so that roots, branches, and trunks are protected from damage or injury.
- H. Immediately before transplanting a tree, the Contractor shall thoroughly spray the tree with an antidesiccant solution. The antidesiccant shall be applied using a power sprayer capable of thoroughly coating the tree's foliage, trunks, branches, stems, and twigs. Two weeks after transplanting the antidesiccant solution shall be sprayed again on the transplanted tree.
- I. All holes, depressions, or disturbances left by the removal of a transplanted tree shall be backfilled by the Contractor to original or proposed final elevations.
- J. Due to construction scheduling conflicts, trees that cannot be immediately transplanted to their final location shall be held in a temporary holding area. The location of the temporary holding area shall be coordinated with the Owner. The Contractor shall be responsible for providing all necessary irrigation systems, heads, piping, controllers, maintenance, etc. in the temporary holding area.

3.3 SITE PREPARATION FOR TRANSPLANTED TREES

- A. No tree pit shall be dug or prepared until their final location has been staked in the field by the Contractor and its location approved by the Owner. Special care shall be exercised to have pits prepared and adequate irrigation (whether permanent or temporary) in place before moving trees to their respective locations to ensure that the tree rootballs will not dry out or that the tree will not be moved more than necessary.
- B. Circular pits with vertical sides shall be excavated for all trees. The depth of all plant pits shall be enough to accommodate the ball or roots and the prepared soil in the bottom of the pit. Diameter of pits for trees shall be at least 4 feet greater than the diameter of the ball.
- C. Pits shall be tested for proper drainage by filling with water twice in succession. Conditions permitting the retention of more than 6 inches of water in 1 hour shall be brought to the attention of the Owner. A written proposal and cost estimate for

correction of such conditions shall be submitted to the Owner for acceptance, before proceeding with the work.

- D. All tree pits in curbed planting islands, tree wells, or in areas in which the soil has been compacted to an undesirable density, shall be excavated to a depth at least two feet greater than the measured depth and diameter of the ball. The minimum depth and diameter of an excavation shall be four feet. Soil backfill in areas of densely compacted soil must meet specification 2.01A. It is the Contractor's responsibility to dispose of the unsuitable soil to an approved location.
- E. Plants shall be set in the center of pits and shall be plumb and straight and at such a level that after settlement the root crown will be slightly above the surrounding grade.
- F. Plant holes shall be backfilled with the specified planting mixture placed in layers around the roots or ball. Each layer shall be carefully tamped in place in a manner to avoid injury to the roots or disturbing the position of the plant. When approximately two thirds of the plant hole has been backfilled, the hole shall be filled with water and the soil allowed to settle around the roots. After the water has been absorbed, the plant hole shall be filled and tamped lightly to grade. Any subsequent settlement shall be brought to grade.
- G. Immediately after each tree pit is backfilled, a shallow basin slightly larger than the pit shall be formed with a ridge of topsoil to facilitate watering. This soil saucer shall be formed in a circle and tamped around each tree so that the saucer will retain water. Where curbing occurs around plant pits, the saucer shall be omitted.

3.4 STAKING AND GUYING

- A. Immediately after each tree is transplanted it shall be securely staked to maintain the tree in an upright plumb position.

3.5 FERTILIZATION

- A. Each tree shall be fertilized by placing half of the manufacturer's recommended amount around the base of the rootball before backfilling and broadcasting the remaining half of the recommended amount on top of the rootball.

3.6 MULCHING

- A. Immediately after planting operations are completed, all tree saucers shall be covered with a two (2) inch layer of Forest Fines Mulch, available from Agri-Serve 800-262-4167 or owner approved equal.

3.7 CLEANUP

- A. During the course of planting, excess and waste materials shall be continuously and promptly removed daily, lawns kept clear, and all reasonable precautions taken to avoid damage to existing structures, plants and grass. After completion of the work, the entire site shall be cleared of excess soils, waste material, debris and all objects that may hinder maintenance and affect the visual appearance of the site.

3.8 DISTURBED AREAS

- A. All areas outside of the landscape limits of work that are disturbed by the Contractor's construction activities shall be repaired and replanted to its original condition.

3.9 TREE PROTECTION BARRICADES

- A. Prior to the commencement of any construction activities, the Contractor shall erect a protective barricade fence around each tree or group of trees that are indicated on the plan to remain in their current locations. The barricade fencing shall be erected outside of the drip line of the tree to be protected.

3.10 PREPARATION OF EXISTING TREES TO BE SAVED

- A. The Contractor shall field identify all trees that are to be saved in their current locations with colored flagging tape for approval by Owner before any work is begun.
- B. If desired by Owner, the Contractor shall prune and thin out approximately 1/3 of the overhead canopy of all trees to be saved in their current locations. This shall be executed no less than one month prior to construction. All cuts shall be clean and flush and shall be angled to prevent water ponding. Pruning operations shall not adversely affect the shape and character of the trees. Pruning shall remove lateral branches only. All main, primary, and secondary branches shall not be removed.
- C. All vines shall be removed from tree canopies.

3.11 DEMOLITION

- A. The Contractor shall be responsible for the demolition and site preparation of the entire area prescribed. The Contractor shall make himself aware of the proposed new layout of surface and landscape areas and coordinate his work with other Contractors whether part of this contract or as a separate contract with Owner.
- B. Unless otherwise approved by Owner, all demolition within the barricaded areas shall be executed using hand methods or approved small hand held mechanical machinery provided exceptional care is taken to avoid injury to the root system or other portions of the tree. Large mechanical equipment may be used so long as it is not used within the drip line of the trees.
- C. The storage or stockpiling of equipment and material or the unauthorized entry of personnel within the barricaded areas shall be strictly prohibited. The use of the tree's shade within the barricaded area by construction personnel during break periods shall be strictly prohibited.
- D. All excavation around existing trees to remain shall be executed by hand. Where excavations uncover and expose roots that are to remain the Contractor shall cover these roots with 6" of fill immediately to prevent the roots from drying out.
- E. All demolished material shall be removed from site and legally disposed of by the Contractor at no additional charge to the Owner.

- F. Immediately before any root pruning operations, the Contractor shall thoroughly spray the tree with an antidesiccant solution. The antidesiccant shall be applied using a power sprayer capable of thoroughly coating the tree's foliage, trunks, branches, stems, and twigs. Two weeks after root pruning, the antidesiccant solution shall be sprayed again on the tree.
- G. All holes, depressions, or disturbances left by the Contractor's demolition and transplant activities shall be backfilled and brought up to existing grade by the Contractor and covered with Bahia sod. Where new asphalt pavement is to be installed, whether as part of this contract or as a separate contract with the Owner, the Contractor shall backfill and compact up to 12" less than final asphalt grades. This is to allow for the installation of the asphalt subbase and surface costs by the Paving Contractor.
- H. Where proposed landscape areas are to be created the Contractor shall shape and grade the area within the barricade to final finished grade.
- I. Prior to tree and palm demolition, all trees and palms shall be inspected by Owner for possible deadfall harvesting. Contractor shall remove deadfall trees and palms per the direction of the Owner.

3.12 BORICIDE APPLICATION

- A. All existing pine trees to remain in their current locations shall be treated with an approved Boricidex at least one week prior to any construction activities that may affect the health of the trees. Boricidex shall be applied at regular intervals in quantities suggested by the manufacturer throughout the length of the construction period.

3.13 SITE ACCESS

- A. The Contractor shall not close or obstruct roadways, drive isles or other access lanes without the written approval of the Owner. The Contractor is cautioned that portions of the site will remain open to the general public and Owner's employees, personnel, vendors, etc. The Contractor shall exercise extreme care to protect the health and safety of these users. The Contractor shall be responsible for the erection of warning lights and barricades in areas in which the Contractor's construction activities may pose a health threat.

PART 4 - MAINTENANCE

4.1 GENERAL

- A. The Contractor shall be responsible for the care and maintenance of all existing trees to remain and all transplanted trees from planting to final acceptance of each phase of work.

4.2 KEY MAINTENANCE PERSONNEL

- A. Maintenance personnel shall be specifically assigned to monitor the health of all trees under the Contractor's responsibility. It shall be required as part of this contract that key

maintenance personnel be approved by the Owner. These personnel shall be assigned specific and sole responsibility to continuously monitor the health of the trees. In order to maintain continuity these key personnel shall not be dismissed or reassigned to other projects without the written permission of the Owner.

4.3 MAINTENANCE PROCEDURES

- A. Maintenance shall include but not be limited to: fertilization, watering, pruning of dead or sick branches, maintaining stakes and cables to maintain transplanted trees in an upright plumb position, pest/disease control and monitoring, and any other acceptable maintenance practice to maintain the trees in a healthy and vigorous state.

PART 5 - WARRANTY

5.1 WARRANTY

- A. There shall be a guarantee and warranty period for all transplanted trees. The guarantee and warranty period shall start when trees are transplanted from the project site to the holding yard area and continue until trees are transplanted back from holding yard to the project site and attain final acceptance. This time period includes the maintenance period when trees are in the holding yard. Transplanted trees that die or are in a non-correctable poor health condition during the guarantee and warranty period shall be replaced by the Contractor with trees of similar size and species. The exception are trees of 13" caliper or greater which shall be replaced with a similar species tree no less than 12" caliper. Replacement trees shall be approved and selected by the Owner. In addition there shall be a guarantee and warranty period of one year for any and all new replacement trees provided by the Contractor as part of this contract.

END OF SECTION 32 96 00

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SECTION 33 00 10 - TRENCHING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes, but is not necessarily limited to, trench, backfill, and compaction as specified herein and as needed for installation of underground utilities associated with the Work.
- B. Related Work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Section 02 30 00 Subsurface Investigations
 - 3. Section 31 10 00 Site Clearing
 - 4. Section 31 20 00 Earth Moving
 - 5. The Geotechnical Investigation Report and the Geotechnical Engineer.
 - 6. All of the above specifications shall be consulted. The most restrictive specification shall apply.

1.2 QUALITY ASSURANCE

- A. 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.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.
- C. In addition to complying with requirements of governmental agencies having jurisdiction, comply with the recommendations of the Geotechnical Engineer.

1.3 PRODUCT HANDLING

- A. Comply with pertinent provisions of Section 01 60 00, Product Requirements.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Fill and backfill materials:

1. Provide soil materials free from organic matter and deleterious substances, containing no rocks or lumps over 2 inches in greatest dimension.
2. Fill material is subject to the approval of the Geotechnical Engineer, and is that material removed from excavations or imported from off-site borrow areas, predominantly granular, non-expansive soils, free from roots and other deleterious matter.
3. Do not permit rocks having a dimension greater than 1 inch in the upper 12 inches of fill.
4. Cohesionless Material Used for Structural Backfill: Provide sand free from organic material and other foreign matter, and as approved by the Geotechnical Engineer.
5. Bedding material shall meet the minimum standards listed below:

Sand Equivalent	20
<u>Sieve Size</u>	<u>Percentage Passing Sieve</u>
1 inch (2.54 cm)	100
No. 4	80-100
No. 200	0-15

2.2 OTHER MATERIALS

- #### A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- #### A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINISH ELEVATIONS AND LINES

- #### A. Comply with pertinent provision of Section 32 00 10, Field Engineering.

3.3 PROCEDURES

A. Utilities:

1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to trenching. If damaged, repair or replace at no additional cost to the Owner.
2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Engineer and secure instructions.
5. Do not proceed with permanent relocation of utilities until written instructions are received from the Engineer.

B. Protection of Persons and Property:

1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.
2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.

C. Dewatering:

1. Remove all water, including rain water, encountered during trench and substructure work to an approved location by pumps, drains, and other approved methods.
2. Keep excavations and site construction area free from water.

D. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.

E. Maintain access to adjacent areas at all times.

3.4 TRENCHING

A. Comply with pertinent provisions of Section 31 20 00, Earth Moving, and the provisions of this Section.

B. Provide sheeting and shoring necessary for protection of the Work and for the safety of personnel.

1. Prior to backfilling, remove all sheeting.
2. Do not permit sheeting to remain in the trenches except when, in the opinion of the Architect, field conditions or the type of sheeting or methods of construction

such as use of concrete bedding are such as to make removal of sheeting impracticable. In such cases, the Architect may permit portions of sheeting to be cut off and remain in the trench.

C. Open Cut:

1. Excavate for utilities by open cut.
 2. If conditions at the site prevent such open cut, and if approved by the Engineer, trenching may be used.
 3. Short sections of a trench may be tunneled if, in the opinion of the Engineer, the conductor can be installed safely and backfill can be compacted properly into such tunnel.
 4. Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, backfill the voids remaining after removal of the objects as directed by the Geotechnical Engineer.
 5. When the void is below the subgrade for the utility bedding, use suitable earth materials and compact to the relative compaction directed by the soil engineer, but in no case to a relative compaction less than 90%.
 6. When the void is in the side of the utility trench or open cut, use suitable earth or sand compacted, or consolidated as approved by the Geotechnical Engineer, but in no case to a relative compaction less than 90%.
 7. Remove boulders and other interfering objects, and backfill voids left by such removals, at no additional cost to the Owner.
 8. Excavating for appurtenances:
 - a. Excavate for manholes and similar structures to a distance sufficient to leave at least 12 inches clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
 - b. Overdepth excavation beyond such appurtenances that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as directed by the Geotechnical Engineer, and at no additional cost to the Owner.
- D. Trench to the minimum width necessary for proper installation of the utility, with sides as nearly vertical as possible. Accurately grade the bottom to provide uniform bearing for the utility.
- E. Depressions:
1. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
 2. Except where rock is encountered, do not excavate below the depth indicated or specified.
 3. Where rock is encountered, excavate rock to a minimum overdepth of 4 inches below the trench depth indicated or specified.
- F. Where utility runs traverse public property or are subject to governmental or utility company jurisdiction, provide depth, bedding, over, and other requirements as set

forth by legally constituted authority having jurisdiction, but in no case less than the depth shown in the Contract Documents.

G. Cover:

1. Provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade or subgrade:
 - a. Areas Subject to Vehicular Traffic:
 - (1) Sanitary sewers: 48";
 - (2) Storm drains: 36".
 - b. Areas Not Subject to Vehicular Traffic:
 - (1) Sanitary sewers: 30";
 - (2) Storm drains: 18".
 - c. All Areas:
 - (1) Water lines: 30";
 - (2) Natural gas lines: 24";
 - (3) Electrical cables: 42";
 - (4) Electrical ducts: 36".
 - d. Where the minimum cover is not provided, encase the pipes in concrete. Provide concrete with a minimum 28 day compressive strength of 2,500 psi.
 - e. Concrete Encased:
 - (1) Pipe sleeves for water and gas lines: 24";
 - (2) Sanitary sewers and storm drains: 12";
 - (3) Electrical ducts: 24".
2. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, and electrical long-radius rigid metal conduit riser, provided it will not interfere with the structural integrity of the slab or pavement.

3.5 BEDDING

- A. Bedding for trenches is that material supporting, surrounding, and extending to 1 foot above the top of the pipe. Where concrete is specified to cover the pipe, the top of the concrete shall be considered as the top of the bedding.
- B. Where it becomes necessary to remove boulders or other interfering objects at subgrade for bedding, any void below such subgrade shall be filled with the bedding material.
- C. Bedding material, approved by the Geotechnical Engineer and meeting the minimum standards listed in Section 2.1.A.5 shall be deposited and compacted to 90% relative compaction in the trench uniformly on both sides of the pipe for the full width of the trench and to a depth of 12 inches over the top of the pipe. For pipes larger than 48 inches diameter, bedding material shall be placed up to spring-line.

3.6 BACKFILLING

A. General

1. Do not completely backfill trenches until required pressure and leakage tests have been performed and until the utilities systems as installed conform to the requirements specified in the pertinent Sections of these Specifications.
2. Except as otherwise specified or directed for special conditions, backfill trenches to the ground surface with selected material approved by the Geotechnical Engineer.
3. Reopen trenches that have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified or otherwise correct to the approval of the Geotechnical Engineer.
4. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, tests, and approvals.
5. Should any of the Work be so enclosed or covered up before it has been approved, uncover all such Work and, after approvals have been made, refill and compact as specified, all at no additional cost to the Owner.

B. Lower Portion of Trench:

1. Deposit approved backfill and bedding material in layers of 6 inches maximum thickness, and compact with suitable tampers to the minimum density directed by the Geotechnical Engineer.
2. Take special care in backfilling and bedding operations to not damage pipe and pipe coatings.

C. Remainder of Trench:

1. Deposit backfill materials in layers not exceeding 6 inches in thickness, and compact each layer to the minimum density directed by the soil engineer. It shall be compacted to a relative compaction of 90% for the remainder of the trench, except that the top 12 inches shall be brought to 95% compaction. The backfill under and around any and all pipes shall be thoroughly consolidated before any additional material is placed.

D. Adjacent to Buildings: Mechanically compact backfill within ten feet of buildings.

E. Consolidation of backfill by jetting with water may be permitted, when specifically approved by the Geotechnical Engineer, in areas other than building and pavement areas.

3.7 TEST FOR DISPLACEMENT OF SEWERS AND STORMDRAINS

- A. Check sewers and storm drains to determine whether displacement has occurred after the trench has been backfilled to above the pipe and has been compacted as specified.

- B. Visual Inspection: Flash a light between manholes or, if the manholes have not yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror to inspect the inside of the pipe.
- C. Deflection Test: If visual inspection demonstrates potential deflection failure, an odd-leg mandrel (go-no-go) shall be pulled through the installed pipe. Deflection shall not exceed manufacturer's recommendation. Testing shall be done within 30 days of installation.
- D. If the illuminated interior of the pipe line or the deflection test shows poor alignment, displaced pipes, or any other defects, correct the defects to the specified conditions and at no additional cost to the Owner.

3.8 PIPE JACKING

- A. The Contractor may, at his option, install steel pipe casings, tongue-and-groove reinforced concrete pipes, and steel pipes under existing roads or pavements by jacking into place using procedures approved by the governmental agencies having jurisdiction and approved by the Geotechnical Engineer.

3.9 TUNNELING OPERATIONS

- A. The Contractor may, at his option, tunnel pipes into position using procedures approved by the Geotechnical Engineer and the governmental agencies having jurisdiction.

3.10 FIELD QUALITY CONTROL

- A. The Geotechnical Engineer will inspect and approve open cuts and trenches before installation of utilities, and will make the following tests:
 - 1. Assure that trenches are not backfilled until all tests have been completed;
 - 2. Check backfilling for proper layer thickness and compaction;
 - 3. Verify that test results conform to the specified requirements, and that sufficient tests are performed;
 - 4. Assure that defective work is removed and properly replaced.

END OF SECTION 33 00 10

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SECTION 33 05 13 – MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

- A. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2003 (Reapproved 2016).
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- C. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections 2018.
- D. ASTM C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections (Metric) 2018.
- E. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals 2018.
- F. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric) 2018.

1.2 SUBMITTALS

- A. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.
- B. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- C. Manufacturer's Qualification Statement.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M), with resilient connectors complying with ASTM C923 (ASTM C923M).
- B. Lid and Frame: ASTM A48/A48M Class 30B Cast iron construction, machined flat bearing surface, removable lockable lid, closed lid design; H-20 load rated; lid molded with identifying name.
- C. Manhole Steps: Formed galvanized steel rungs; 3/4 inch (19 mm) diameter. Formed integral with manhole sections.

2.2 CONFIGURATION (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION 33 05 13

SECTION 33 14 16 – SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water pipe for site conveyance lines.
- B. Pipe Valves.
- C. Fire hydrants.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints.
- B. Section 21 11 00 - Facility Fire-Suppression Water-Service Piping.
- C. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- D. Section 33 05 13 - Manholes and Structures.

1.3 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2016.
- B. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250 2016.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2018.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
- E. 53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless 2018.
- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2016.
- G. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2017.
- H. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2015.
- I. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals 1998 (Reapproved 2011).
- J. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2011 (Amended 2012)
- K. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings 2017.
- L. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service 2015.

- M. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances 2017.
- N. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution 2016.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

2.1 WATER PIPE

- A. Ductile Iron Pipe: AWWA C151/A21.51:
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- B. Copper Tubing: ASTM B88, Type K, Annealed:
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- C. PVC PIPE: AWWA C900 Class 100:
 - 1. Fittings: AWWA C111/A21.11, Schedule 40 per ASTM D2466 or schedule 80 per ASTM D2467.
 - 2. Joints: ASTM D3139 compression gasket ring.
- D. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters

2.2 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves Up To 3 Inches (75 mm):
 - 1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
- C. Gate Valves 3 Inches (75 mm) and Over:
 - 1. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, post indicator, valve key, and extension box.

D. Ball Valves Up to 2 Inches (50 mm):

1. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA inlet end, compression outlet with electrical ground connector, with control rod, valve key, and extension box.

2.3 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.
- B. Potable Backflow Preventer: Wilkins Model 375 Reduced Pressure Backflow Preventer
- C. Fire Backflow Preventer: Wilkins Model 350 Double Detector Check Assembly
- D. Meter: To be determined by Cal Poly University.
- E. Manhole and Cover: Refer to Section 33 05 13.

PART 3 - EXECUTION

3.1 INSTALLATION – PIPE

- A. Install ductile iron piping and fittings to AWWA C600.
- B. Route pipe in straight line.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- D. Slope water pipe and position drains at low points.

3.2 INSTALLATION – VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway in accordance with Section 21 11 00.
- D. Set hydrants to grade, with nozzles at least 20 inches (500 mm) above ground in accordance with Section 21 11 00.

END OF SECTION 33 14 16

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SECTION 33 31 13 – SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.2 REFERENCE STANDARDS

- A. D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications 2018.
- B. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2016.

1.3 SUBMITTALS

- A. Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide all product data from the manufacturer to the University and engineer for review.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents:
 - 1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material, extra strength, minimum of SDR 35; inside nominal diameter per drawings, bell and spigot style solvent sealed joint end.
- C. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.2 PIPE ACCESSORIES

- A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

2.3 CLEANOUT MANHOLE

- A. Lid and Frame: Cast iron construction, hinged lid.
- B. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches (300 mm); nominal shaft diameter of 36 inches (900 mm).

PART 3 - EXECUTION

3.1 TRENCHING

- A. See Section 31 23 16.13 for additional requirements
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION – PIPE

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- C. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.
- D. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 23 16.13.

3.3 INSTALLATION – CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

END OF SECTION 33 31 13

SECTION 33 31 23 - SANITARY SEWERAGE FORCE MAIN PIPING

PART 1 – GENERAL (Not Used)

PART 2 - PRODUCTS

2.1 FORCE MAIN PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

PART 3 – EXECUTION (Not Used)

END OF SECTION

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SECTION 33 42 11 – STORMWATER GRAVITY PIPING

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

- A. D3034 - Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings 2016.

1.2 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this section.

2.2 SEWER PIPE MATERIALS

- A. Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) material; inside nominal diameter of 8 inches (200 mm), bell and spigot style solvent sealed joint end.
- B. Plastic Pipe: ASTM F2306, Dual-Wall, High Density Polyethylene (HDPE) material; inside nominal diameter of 12 inches (305 mm), bell and spigot style joint end.

2.3 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.4 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

A. Lids and Drain Covers: Cast iron, steel.

1. Catch Basin:
 - a) Lid Design: Linear steel grill.
 - b) Nominal Lid and Frame Size: 18 inches (460 mm) square.
2. Landscape Drain:
 - a) Lid Design: Cast iron domed grate.
 - b) Nominal Lid and Frame Size: 4 inches (100 mm) round.

PART 3 – EXECUTION (Not Used)

END OF SECTION 33 42 11

SECTION 33 52 16 – GAS HYDROCARBON PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and fittings for natural gas distribution on site outside buildings.

1.2 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping.
- B. Section 23 11 23 - Facility Natural-Gas Piping.
- C. Section 31 23 16.13 – Trenching: Excavating, bedding, and backfilling.

1.3 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Comply with ASME BPVC and applicable state regulations.
- B. Welders Certification: In accordance with ASME BPVC-IX.
- C. Comply with NFPA 58.

PART 2 - PRODUCTS

2.1 PIPE

- A. Natural Gas Piping: Specified in Section 23 11 23.
- B. Steel Pipe: ASTM A53/A53M, Schedule 40 black:
 - 1. Fittings: ASME B16.11 forged steel, or ASTM A234/A234M wrought steel welding type.
 - 2. Joints: Welded, gas tungsten arc method.
 - 3. Jackets: AWWA C105/A21.5 polyethylene jacket.
- C. Steel Pipe Above Ground: ASTM A53/A53M, Schedule 40 black:
 - 1. Fittings: ASME B16.3 malleable iron, ASME B16.11 forged steel, or ASTM A234/A234M wrought steel welding type.
 - 2. Joints: Threaded.
- D. Polyethylene Pipe: ASTM D2513, SDR11:

2.2 GAS HYDROCARBON PIPING

- A. Gas Cock and Pressure Regulating Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gas Cocks Up to 2 Inches (50 mm): 150 psig (1,040 kPa) water or gas (WOG), bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends with cast iron curb box, cover, and key.
- C. Gas Cocks Over 2 Inches (50 mm): 125 psig (860 kPa) WOG, Steel body and tapered plug, non-lubricated, Teflon packing, threaded ends, with cast iron curb box, cover, and key.
- D. Pressure Regulating Valves: Single stage, malleable iron body, corrosion-resistant, pressure regulator with atmospheric vent, elevation compensator; with threaded ends for 2 inch (50 mm) and smaller, flanged ends larger than 2 inch (50 mm).

PART 3 - EXECUTION

3.1 TRENCHING

- A. See Section 31 23 16.13 for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION – PIPE

- A. Group piping with other site piping work whenever practical.
- B. Route piping in straight line.
- C. Install piping to conserve space and not interfere with use of site space.
- D. Install piping to allow for expansion and contraction without stressing pipe or joints.
- E. Install cocks and other fittings.
- F. Establish elevations of buried piping to ensure not less than 24 inches (600 mm) of cover in non-travelled areas and 48 inches (1,200 mm) of cover in driveways and parking areas.
- G. Wrap couplings and fittings of steel pipe with polyethylene tape and heat shrink over pipe.
- H. Center and plumb valve box over valve. Set box cover flush with finished ground surface. Prevent shock or stress from being transmitted through valve box to valve.

END OF SECTION 33 52 16

**Cal Poly University
San Luis Obispo**

TECH PARK PHASE 2

Appendix A
Geotechnical Report



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**GEOTECHNICAL ENGINEERING REPORT
CAL POLY TECH PARK II
MOUNT BISHOP ROAD
CAL POLY
SAN LUIS OBISPO, CALIFORNIA**

July 19, 2021

Prepared for

Mr. Curtis McNally

Prepared by

Earth Systems Pacific
4378 Old Santa Fe Road
San Luis Obispo, CA 93401

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July 19, 2021

FILE NO.: 300986-048

Mr. Curtis McNally
Facilities Planning and Capital Projects, Bldg. 70
California Polytechnic State University
San Luis Obispo, CA 93407

PROJECT: CAL POLY TECH PARK – PHASE II
MOUNT BISHOP ROAD
CAL POLY, SAN LUIS OBISPO, CALIFORNIA

SUBJECT: Geotechnical Engineering Report

CONTRACT

REF: Purchase Order 2000021168 MJ0085 Tech Park II, dated February 22, 2021

Dear Mr. McNally:


In accordance with the above-referenced agreement, this geotechnical engineering report has been prepared for use in the development of the Cal Poly Tech Park – Phase II which is planned to be constructed between parking lots H-1 and buildings 50J and 50K off of Mount Bishop Road at the campus of Cal Poly, San Luis Obispo, California. We understand the project will include a new pre-engineered metal building and minor site work, including concrete pedestrian walkways, site retaining walls, and driveways/loading areas. We further understand that the new building is planned to be two stories with concrete slabs-on-deck for the second story and slabs-on-grade for the first, and that shallow spread footings are planned. Based upon the structure type described, foundation loads of 3 klf and maximum isolated foundation loads of 50 kips have been used in preparation of this report.

Preliminary geotechnical engineering recommendations for site preparation, grading, utilities, foundations, interior slabs-on-grade and exterior pedestrian flatwork, site retaining walls, vehicular pavements, drainage and maintenance, and observation and testing are presented herein. One electronic copy and two paper copies have been provided to you.

We appreciate the opportunity to have provided professional services for this project and look forward to working with you again in the future. If there are any questions concerning this report, please do not hesitate to contact the undersigned.

Sincerely,

Earth Systems Pacific


Robert Down, PE
Associate Engineer




Kenrick Koo
Engineering Intern

Doc. No.: 2107-041.SER/pm



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1.0 INTRODUCTION AND SITE SETTING

The proposed project will be constructed between parking lot H-1 and buildings 50J and 50K off Mount Bishop Road on the Cal Poly Campus, San Luis Obispo, California and will include a new pre-engineered metal building and minor site work, including concrete pedestrian walkways, site retaining walls, and driveways/loading areas.

The new tech park building will be two-stories and will have slabs-on-grade for the first story and concrete slabs-on-deck for the second story. We anticipate new parking areas will be surfaced with Hot Mix Asphalt (HMA). Storm water control measures (SCM) are also planned for this project. We anticipate cuts and fills of up to three feet.

Approximate site coordinates of latitude 35.3039N and longitude 120.6703W were obtained from Google Earth (2021) and were taken at the approximate location shown on Figure 1 – Site Vicinity Map. The site is bordered by parking lot H-1 on the east, buildings 50J and 50K on the west, the existing Tech Park to the north, and agricultural fields part of the Cal Poly campus on the south. The site is accessed by turning west off Mount Bishop road, through the H-1 parking lot. Part of the northern area of the site is fenced. The site is relatively level and is roughly located at Elevation 292 feet.

2.0 SCOPE OF SERVICES

The authorized scope of work included a general site reconnaissance, field exploration, laboratory and infiltration testing, geotechnical analysis of the data gathered, and preparation of this report.

This report and recommendations are intended to comply with the considerations of Sections 1803.1 through 1803.6, J104.3 and J104.4, as applicable, of the 2019 California Building Code (CBC) and common geotechnical engineering practice in this area under similar conditions at this time. The test procedures were accomplished in general conformance with the standards noted, as modified by common geotechnical engineering practice in this area under similar conditions at this time.

Preliminary geotechnical engineering recommendations for site preparation, grading, foundation design, interior slabs-on-grade and exterior pedestrian flatwork, site retaining wall design criteria, HMA pavement design criteria, drainage, and observation and testing are presented to guide the development of project plans and specifications. As there may be geotechnical issues



yet to be resolved, the geotechnical engineer should be retained to provide consultation as the design progresses, and to review project plans as they near completion, and to assist in verifying that pertinent geotechnical issues have been addressed and to aid in conformance with the intent of this report. It is our intent that this report be used exclusively by the client to form the geotechnical basis of the design of the project and in the preparation of plans and specifications. Application beyond this intent is strictly at the user's risk.

This report does not address issues in the domain of contractors such as, but not limited to, site safety, loss of volume due to stripping of the site, shrinkage of soils during compaction, construction means and methods, etc. Analyses of site or areal geology or the soil for radioisotopes, asbestos (either naturally occurring or in man-made products), lead or mold potential, hydrocarbons, or chemical properties is beyond the scope of this report. Ancillary features such as flag or light poles, temporary access roads, and non-structural fills are not within our scope and are also not addressed.

In the event that there are any changes in the nature, design, or location of improvements, or if any assumptions used in the preparation of this report prove to be incorrect, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified by the geotechnical engineer in writing. The criteria presented in this report are considered preliminary until such time as any peer review or review by any jurisdiction has been completed, conditions have been observed by the geotechnical engineer in the field during construction, and the recommendations have been verified as appropriate, or modified by the geotechnical engineer in writing.

3.0 GEOTECHNICAL ENGINEERING INVESTIGATION

Our geotechnical field investigation consisted of three exploratory borings that were performed on May 18th, 2021. The approximate locations of the borings are shown on Figure 2 – Exploration Location Map in Appendix A.

The borings were drilled with a truck-mounted Mobile Drill Model B-53 rig equipped with a 6-inch outside diameter hollow stem auger. The borings were drilled to depths of approximately 5.0 feet to 16.5 feet bgs.

Soils encountered in the borings were visually categorized and logged in general accordance with the Unified Soil Classification System and ASTM D 2488-17. Where bedrock was encountered, its properties were described based upon observation of ring and/or Standard Penetration Test



samples, observation of the auger cuttings, the effort required to drill into the bedrock, and the effort required to drive samplers into the bedrock. Copies of the boring logs and a boring log legend are included in the Appendix A. In reviewing the boring logs and legend, the reader should recognize that the legend is intended as a guideline only, and there are a number of conditions that may influence the characteristics observed during drilling. These include, but are not limited to, the presence of cobbles or boulders, cementation, variations in soil moisture, presence of groundwater, and other factors. It should also be noted that the descriptions of bedrock must span a much wider range of density and strength characteristics than soil and are relative to other *bedrock* strata. For example, fractured and weathered bedrock may be described as “soft,” yet it will be considerably harder than almost any type of soil. Conversely, a clay soil may be described as “hard,” however it will not be nearly as hard as even “soft” bedrock such as that encountered on this site. Consequently, the logger must exercise judgment in interpreting the subsurface characteristics, possibly resulting in soil and bedrock descriptions that vary somewhat from the legend.

4.0 STORMWATER CONTROL MEASURES INFILTRATION TESTING

An additional two test borings for infiltration testing were drilled using the truck-mounted Mobile Drill Model B-53 rig. After drilling was completed, a 2-inch diameter perforated pipe was installed in each of the infiltration test borings where the annular spaces around the pipes were filled with gravel. Infiltration testing was performed in accordance with the methods developed by this firm in cooperation with the Central Coast Low Impact Development Initiative (ESP 2013).

Initially, testing consisted of introducing water into each of the test borings to just below existing grade. This water level was then maintained at constant head for 30 minutes. After the 30-minute period, the water was shut off and the amount of water introduced into each of the test borings was recorded. Readings of the change in water level were then recorded at various time intervals over periods ranging for approximately four hours. Following testing, the pipes were removed, and the test borings were backfilled with on-site soil. The SCM infiltration test results are attached in Appendix C.

Constant head infiltration testing resulted in introducing 5.0 gallons of water over a period of 30 minutes. Stabilized falling head test were 1.5 in/hr near the end of the test. The test results only indicate the infiltration rates at the specific locations tested and under specific conditions. Sound engineering judgment should be exercised in extrapolating the test results for other conditions or locations. Technical design references vary in methods they present for using these types of



test results. However, most references include reduction, safety, and/or correction factors for several parameters including, but not limited to, size of the LID system relative to the test volume, number of tests conducted, variability in the soil profile, anticipated silt loading, anticipated biological buildup, anticipated long-term maintenance, and other factors. Typically, in aggregate these factors range from about 2.5 to 50 depending upon the method used. The final determination of the means by which these data are used is left to the design engineer.

5.0 LABORATORY ANALYSIS

Selected samples from the borings were tested in our laboratory for bulk density (ASTM D 2937-17, modified for ring liners), moisture content (ASTM D 2216-10), expansion index (ASTM D 2937-19), plasticity index (ASTM D 4318-17), grain size distribution by sieve analysis (ASTM D 422-63/07; ASTM D 1140-17), maximum density and optimum moisture content (ASTM D 1557-12 Modified), and cohesion and angle of shearing resistance (ASTM D 3080/3080M-11). The results of the laboratory tests are presented in Appendix B.

6.0 GENERAL SUBSURFACE PROFILE

Based upon our subsurface exploration, the site is underlain by alluvium and bedrock. The alluvium extended to depths that ranged from 2.0 to 15.0 feet bgs and consisted mainly of medium stiff to hard lean clays with variable amounts of sand, gravel, and silt; clayey sands; poorly graded gravel and medium stiff fat clay with variable amounts of sand and gravel. Underlying the alluvium, sandstone bedrock of the Franciscan Mélange was encountered in the borings. The bedrock encountered in the borings was moderately hard and intensely weathered. No subsurface water was encountered.

However, it should be noted that it is common on campus to have groundwater seepage at the soil/bedrock contact and this should be anticipated during construction, especially during and following the winter months. This water should be easily managed during construction with small gravel layers and/or sump pumps, if needed.

7.0 CONCLUSIONS

In our opinion, the site is suitable, from a geotechnical engineering standpoint, for the proposed development discussed in the “Introduction and Site Setting” Section of the report, provided the recommendations contained herein are implemented in the design and construction. In our opinion, the primary geotechnical engineering concerns at the site are the potential for strong



seismic shaking, differential settlement, and expansion potential of the site soil. Liquefaction potential and erosion potential is also discussed below.

Potential for Strong Seismic Shaking

The site is in a region of high seismic activity, with the potential for large seismic events that could generate strong ground shaking. The California State University (CSU) has adopted campus-specific seismic ground motion parameters which supersede the California Building Code (CBC). As required by the CSU Seismic Requirements (CSU 2020), seismic ground motion parameters from Attachment B of the CSU Seismic Requirements are included in this report. Seismic acceleration parameters below should be utilized to reduce the impact of a seismic event on the project site.

The following table provides San Luis Obispo campus-specific seismic parameters as reported by the CSU System, detailing that the campus is not within an active fault zone and closest UCERF3 Faults used for deterministic ground shaking considerations are the Oceanic-West Huasna and Hosgri faults. Based on data from our borings, the subsurface characteristics are those of Site Class D – Stiff Soil, as defined by Table 20.3-1 of ASCE 7-16.

TABLE 1: CSU SAN LUIS OBISPO CAMPUS SPECIFIC SEISMIC PARAMETERS (CSU 2020)

Seismic Design Category	D
Site Class	D
MCE Spectral Response Acceleration Ground Motion	
Peak Ground Acceleration, PGA_M	0.54 g
Short Period Spectral Response, S_{MS}	1.15 g
1 second Spectral Response, S_{M1}	0.75 g
Design Earthquake Ground Motion	
Peak Ground Acceleration, PGA_D	0.36 g
Short Period Spectral Response, S_{DS}	0.77 g
1 second Spectral Response, S_{D1}	0.50 g



Soil Expansion Potential

Expansion index testing of the near-surface soils yielded results of 44 and 83. Per Section 1803.5.3 of the 2019 CBC, these soils are considered to be expansive, with “medium” expansion potentials per ASTM D 4829-19. Expansive soils tend to swell with increases in soil moisture and shrink as soil moisture decreases; the upper 3 to 5 feet of soil is the zone most affected by these seasonal soil moisture fluctuations. The volume changes that these materials undergo in this cyclical pattern can damage slabs and foundations if precautionary measures are not incorporated into the design and construction procedures. Recommendations for reducing the potential for damage to the proposed improvements, including moisture conditioning the soil, placement of non-expansive fill, and deepening foundations, are provided in the “Preliminary Geotechnical Recommendations” Section of this report.

Settlement Potential

Differential settlement can occur when foundations or surface improvements span materials with significantly different compression characteristics such as bedrock and soil. The portion of the improvements supported by the softer or deeper soft material will settle more than the portion supported by the firmer material. Based upon the subsurface conditions, it is feasible that the foundations may be founded on the underlying bedrock and the alluvial soils. Such a situation could stress and possibly damage buildings and surface improvements, often resulting in severe cracks and displacement. Total settlement, even if relatively uniform across the building, can also adversely affect the grades and utility penetrations adjacent to improvements.

Based upon the current plan as described in the introduction, we anticipate shallow foundation systems with continuous and spread footings will be suitable for the proposed structures and overexcavation and re-grading of the upper soils and bedrock will be sufficient to reduce the differential and total settlement to acceptable levels. Grading recommendations are provided in the recommendation section of this report.

Liquefaction Settlement

The site is mapped by the City of San Luis Obispo (2014) as being in an area of moderate liquefaction potential. However, due to the relatively shallow depth to bedrock and the lack of subsurface water encountered in our borings, it is our opinion the potential for damage due to liquefaction at the site is very low.



Erosion Potential

The soils are considered erodible. Caution should be exercised to protect the soil from erosion during and following construction.

8.0 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

These recommendations are applicable for the proposed project as described in the “Introduction and Site Setting” Section of this report. If other improvements not previously mentioned are included, the geotechnical engineer should be contacted for revised recommendations.

Unless otherwise noted, the following definitions are used in the recommendations presented below. Where terms are not defined, definitions commonly used in the construction industry are intended.

- **Building Area:** The area within and extending a minimum of 5 feet beyond the perimeter of the foundations of the proposed technical building and processing building. The building area also includes the footprint of any improvements which are rigidly connected to the structure, such as columns for covered walkways, and that are expected to perform in a similar manner.
- **Site Retaining Wall Foundation Area:** The area within and extending a minimum of 5 feet beyond the perimeter of the foundations for site retaining walls.
- **Flatwork Areas:** The areas within and extending a minimum of 1 foot beyond the limits of exterior pedestrian flatwork.
- **Vehicular Pavement Areas:** The areas within and extending a minimum of 5 feet beyond the limits of the pavement area.
- **Subgrade:** The elevation of the surface upon which a sand cushion/nonexpansive imported material or aggregate base (AB) will be placed for vehicular pavement or flatwork.
- **Existing Grade:** Elevations of the site that existed as of the date of this report.
- **Finish Pad Grade:** The elevation in the building area where earthwork operations are typically considered to be complete. It does not include any sand or gravel that might be placed below slabs in association with vapor protection for the slabs.



- **Scarified:** Thoroughly plowed or ripped in two orthogonal directions to a depth of not less than 8 inches.
- **Moisture Conditioned:** Soil moisture content adjusted to optimum moisture content, or just above, prior to application of compactive effort.
- **Compacted/Recompacted:** Soils placed in level lifts not exceeding 8 inches in loose thickness and compacted to a minimum of 90 percent of maximum dry density, unless specified otherwise. The standard tests used to establish maximum dry density and field density should be ASTM D 1557-12 and ASTM D 6938-17, respectively, or other methods acceptable to the geotechnical engineer and jurisdiction.

Site Preparation

1. The ground surface in the grading area should be prepared for construction by removing all existing improvements, foundations, pavement sections, concrete, debris, and other deleterious materials. Any existing utility lines that will not remain in service should be either removed or abandoned. The appropriate method of utility abandonment will depend upon the type and depth of the utility. Recommendations for abandonment during construction can be made by the geotechnical engineer as necessary.
2. Voids created by the removal of materials or utilities described above should be called to the attention of the geotechnical engineer. No fill should be placed unless the underlying soil has been observed by the geotechnical engineer.

Grading

1. Following site preparation, soils within the building area should be removed to a level plane at a minimum depth of 2 feet below planned bottom-of-footing elevation, or 2 feet below existing grade, whichever is deeper. The exposed surfaces should then be scarified, moisture conditioned and recompacted. Where bedrock is exposed, scarification is not required.
2. Following site preparation, soils within the site retaining wall foundation areas should be removed to a level plane at a minimum depth of 2 feet below planned bottom-of-footing elevation, or 2 feet below existing grade, whichever is deeper. The exposed surfaces should then be scarified, moisture conditioned and recompacted. Where bedrock is exposed, scarification is not required.



3. Following site preparation, exterior pedestrian flatwork areas and vehicular pavement areas should be overexcavated to a depth of 1 foot below planned subgrade elevation or existing grade, whichever is deeper. The soil surface exposed by overexcavation should be scarified, moisture conditioned, and recompacted.
4. In the remainder of the grading area, the exposed and prepared soils should be scarified to a minimum depth of 1 foot, moisture conditioned, and recompacted to a minimum of 90 percent of maximum dry density.
5. Voids created by dislodging cobbles and/or debris during scarification should be backfilled and recompacted, and the dislodged materials should be removed from the work area.
6. Previously excavated site soil may be compacted as general fill within the grading area with the exception of the non-expansive layer below the building slab and flatwork areas or aggregate base. The top of the building area should consist of a minimum of 18 inches of nonexpansive fill.
7. All imported soil used on the site should be nonexpansive. Nonexpansive materials are defined as soils that fall in the GW, GM, GC, SP, SW, SC and SM categories per ASTM D 2487-17, and that have an expansion index of 10 or less (ASTM D 4829-11).
8. Proposed imported soils should be evaluated by the geotechnical engineer before being used and on an intermittent basis during placement on the site.
9. All fill should be cleaned of any rocks, debris, and irreducible material larger than 6 inches in diameter. When fill contains rocks, they should be placed in a sufficient soil matrix to ensure that voids caused by nesting of the rocks do not occur and that the material can be properly compacted.
10. It may be difficult to achieve stability if the soils being compacted have well above optimum moisture contents. In those cases, it may be necessary to dry the soils through scarification or mixing with dry soil in order to achieve stable conditions. Other options to achieve stable conditions may include replacement of unstable soil with gravel or Class 2 aggregate base and potentially incorporating stabilization fabric or geogrid. Detailed stabilization recommendations may be provided, if requested, upon examination of actual field conditions by the Geotechnical Engineer. Based upon the moisture contents in the borings, drying of the upper soils should be anticipated, at a minimum.



11. The recommended soil moisture content should be maintained throughout construction, and during the life of the structure and sitework improvements. Failure to maintain the recommended soil moisture content can result in development of cracks and disturbance, which are an indication of degradation of the degree of soil compaction. If cracks are allowed to develop, or if soils near improvements such as foundations, flatwork, pavement, curbs, etc. are otherwise disturbed, damage to those improvements may result. Soils that have been or are otherwise disturbed should be removed, moisture conditioned, and recompacted.
12. Generally, permanent cut and fill slopes should not exceed a 2:1 (horizontal:vertical) gradient, unless otherwise recommended by the geotechnical engineer.

Utilities

1. Unless otherwise recommended, utility trenches adjacent to foundations should not be excavated within the zone of foundation influence, as shown on Typical Detail A presented in Appendix D.
2. Utilities that will pass beneath a foundation should be placed with properly compacted utility trench backfill, and the foundation should be designed to span the trench.
3. A select, non-corrosive, easily compacted sand should be used as bedding and shading immediately around utilities. Trench backfill, above the select material, may be site soils up to subgrade or the planned bottom of non-expansive fill.
4. In general, trench backfill should be compacted to a minimum of 90 percent of maximum dry density. Trenches located within areas to be paved should be compacted to a minimum of 95 percent of maximum dry density within the upper foot of subgrade and all aggregate base.
5. Trench backfill should be placed in level lifts not exceeding 6 inches in loose thickness, moisture conditioned, and compacted to the minimums noted above.
6. Long-term settlement of properly compacted, imported sand or crushed gravel trench backfill should be assumed to be about 0.2 to 0.5 percent of the depth of the backfill; long-term settlement of properly compacted site soil or crushed sandstone trench backfill



should be assumed to be about 0.5 to 1 percent of the depth of the backfill. Improvements that are constructed over or near trenches should be designed to accommodate long-term settlement.

7. Compaction of trench backfill by jetting or flooding is not recommended except under extraordinary circumstances. However, to aid in *encasing* utility conduits, particularly corrugated drain pipes, and multiple, closely spaced conduits in a single trench, jetting or flooding may be useful. Flooding or jetting should only be attempted with extreme caution, and any jetting operation should be subject to review by the geotechnical engineer.
8. The recommendations of this section are minimums only and may be superseded by the requirements of the architect/engineer, the recommendations of pipe manufacturers or utility companies, or the requirements of the governing jurisdiction based upon soil corrosivity or other factors.

Foundations

1. Continuous and spread footings may be used to support the proposed structures, including site retaining walls. The footings should be constructed at a minimum overall depth of 24 inches below lowest adjacent grade and should bear in excavations cut neat into compacted fill. Footing excavations should be horizontal and stepped as needed to bear in uniform material.
2. Continuous footings and grade beams should be reinforced, at a minimum, by two No. 4 rebar at the top and the bottom, or as required by the architect/engineer. Spread footings should be reinforced in accordance with the requirements of the architect/engineer. Spread footings should be connected by grade beams on two sides to create a foundation systems that acts as a single unit.
3. Footings bearing into firm compacted fill may be designed using maximum allowable bearing capacities of 2,000 psf for dead loads and 3,000 psf for dead plus live loads. Using these criteria, maximum total and differential static settlements are expected to be less than 1-inch. Allowable capacities may be increased by one-third when transient loads such as wind or seismicity are included.



4. In calculating resistance to lateral loads, ultimate passive equivalent fluid pressures of 350 pcf may be used for foundations bearing in compacted fill. A coefficient of friction of 0.30 may also be utilized in the design. The lateral capacities are based on the assumption that the soil adjacent to the foundations is properly compacted. Passive and friction resistance components may be combined in the analysis without reduction to either value.
5. Foundation excavations should be observed by the geotechnical engineer during excavation and prior to placement of formwork, reinforcing steel or concrete. Soil in foundation excavations should have a moisture content of optimum moisture content or just above and no desiccation cracks should be present prior to concrete placement.

Interior Slabs-on-Grade and Exterior Pedestrian Flatwork

Interior Slabs-on-Grade

1. Interior slabs-on-grade should have a minimum thickness of 4 inches. They should be reinforced and doweled to foundations per the specifications of the architect/engineer. At a minimum, interior slabs should be reinforced with No. 4 rebar placed at 18 inches on center each way. All structural slabs should contain minimum rebar meeting the criteria of ACI 318, Section 24.4 (ACI 2014). At a minimum, foundation dowels should be lap spliced to the slab rebar. The size and spacing of the dowels should match the size and spacing of the slab rebar.

Exterior Pedestrian Flatwork

1. Exterior pedestrian flatwork should have a minimum thickness of 4 inches. Minimum reinforcement for exterior pedestrian flatwork should consist of No. 3 rebar placed at 24 inches on-center each way.
2. In conventional construction, it is common to use 4 to 6 inches of imported sand beneath exterior pedestrian flatwork. However, due to the medium to high expansion potential of the site soils, there will be a risk of movement and damage to the flatwork and slabs if conventional measures are used – heaving and cracking could occur. To reduce the potential for movement and damage, flatwork should be supported on at least 18 inches of nonexpansive imported soils if desired performance is to be similar to interior slabs on grade.



3. For an added level of protection against expansion, the flatwork can be provided with perimeter trenched edges a minimum of 3 inches deeper than the chosen nonexpansive layer. The trenched edges should be reinforced with No. 4 rebar top and bottom. The decision regarding the thickness of nonexpansive material to use below flatwork, as well as the use of trenched edges, is left to the architect/engineer or owner.
4. Exterior pedestrian flatwork should have thickened edges a minimum of 6 inches below the bottom of the slab.
5. Flatwork should be constructed with frequent joints to allow articulation as the flatwork moves in response to seasonal soil temperature and moisture variations. The soil below flatwork should be moisture conditioned prior to casting the flatwork.
6. Flatwork surfaces should be sloped to freely drain toward appropriate drainage facilities. Water should not be allowed to stand or pond on or adjacent to pavement or other improvements as it could infiltrate into the aggregate base and/or subgrade, causing premature pavement deterioration.
7. Flatwork at doorways, and at other areas where maintaining the elevation of the flatwork is desired, should be doweled to the perimeter foundations, at a minimum, by No. 3 dowels lapped to the flatwork rebar at the same spacing of the flatwork. In other areas, the flatwork may be doweled to the foundation or the flatwork may be allowed to “float free,” at the discretion of the architect/engineer. Flatwork that is intended to float free should be separated from foundations by a felt joint or other means.

Moisture Vapor Transmission

1. Due to the current use of impermeable floor coverings, water-soluble flooring adhesives, and the speed at which buildings are now constructed, moisture vapor transmission through slabs is a much more common problem than in past years. Where moisture vapor transmitted from the underlying soil would be undesirable, the slabs should be protected from subsurface moisture vapor. A number of options for vapor protection are discussed below; however, the means of vapor protection, including the type and thickness of the vapor retarder, if specified, are left to the discretion of the architect/engineer.



2. Where specified, vapor retarders should conform to ASTM Standard E1745-17. This standard specifies properties for three performance classes, Class “A”, “B” and “C”. The appropriate class should be selected based on the potential for damage to the vapor retarder during its installation and placement of slab reinforcement and concrete.
3. It should be noted that ASTM E 1745-17 has the same permeance threshold for Class A through Class C (0.1 perms). The class that is chosen will make a difference in how resistant the vapor retarder is to punctures and tears, but it will not insure any better permeance values to protect floor coverings.
4. Several recent studies, including those of ACI Committee 302 (ACI 2015), have concluded that excess water above the vapor retarder increases the potential for moisture damage to floor coverings and could increase the potential for mold growth or other microbial contamination. The studies also concluded that it is preferable to eliminate the typical sand layer beneath the slab and place the slab PCC in direct contact with a vapor retarder, particularly during wet weather construction. However, placing the PCC directly on the vapor retarder requires special attention to specifying the proper vapor retarder, a very low water-cement ratio in the PCC mix, and special finishing and curing techniques.
5. Another option for vapor protection would be the use of vapor-inhibiting admixtures in the slab PCC mix and/or application of a sealer to the surface of the slab. This would also require special PCC mixes and placement procedures, depending upon the recommendations of the admixture or sealer manufacturer.
6. A third option that may be a reasonable compromise between effectiveness and cost considerations would be the use of a subslab vapor retarder protected by a layer of granular material or of clean sand, with the granular material being the preferred choice. The granular material should be easily compactible and have a relatively low fines content and a low wicking potential. Clean sand is defined as a well or poorly graded sand (ASTM D2487-17) of which less than 3 percent passes the No. 200 sieve. The retarder should be covered with a minimum 4 inches of granular material or clean sand. If a Class “A” vapor retarder is specified, the retarder can be placed directly on the compacted soil material. If a less durable vapor retarder is specified (Class “B” or “C”), a minimum of 1 inch of fine-graded material such as a clean sand should be placed over the compacted soil material



to reduce the chance of puncturing the vapor retarder. The materials mentioned above may count as part of the nonexpansive fill section, not in addition to it.

7. If sand is used between the vapor retarder and the slab, it should be moistened only as necessary to promote concrete curing; saturation of the sand should be avoided, as the excess moisture would be on top of the vapor retarder, potentially resulting in vapor transmission through the slab for months or years.
8. Regardless of the underslab vapor retarder selected, proper installation of the retarder is critical for optimum performance. Where utilized, the vapor retarder should be placed a minimum of 1-inch above the flow line of the drainage path surrounding the structures, or 1-inch above the area drain grates if area drains are used to collect runoff around the structures. All seams must be properly lapped, and all seams and utility penetrations properly sealed in accordance with the vapor retarder manufacturer's recommendations and ASTM E1643-18a. At the terminating edges of the vapor retarder, the vapor retarder should be effectively sealed with accessories specifically designed to seal the material to new or existing concrete; details for edge sealing of the vapor retarder should be provided by the architect/engineer.

Slabs-on-Grade - General

1. To reduce shrinkage cracks in all interior and exterior slabs-on-grade, the concrete aggregates should be of appropriate size and proportion, the water/cement ratio should be low, the concrete should be properly placed and finished, contraction joints should be installed, and the concrete should be properly cured. This is particularly applicable to slabs that will be cast directly upon a vapor retarder and those that will be protected from transmission of vapor by use of admixtures or surface sealers. Concrete materials, placement, and curing specifications should be at the direction of the architect/engineer; AC 302.1R-15 (ACI 2015) is suggested as a resource for the architect/engineer in preparing such specification.

Retaining Walls

1. Site retaining walls may be founded in firm recompacted soil. Foundations for all site retaining walls should have a minimum depth (not including the keyway) of 27 inches below lowest adjacent grade within 8 feet of the footing.



2. Retaining wall footings should be reinforced in accordance with the requirements of the architect/engineer; however, minimum reinforcement should consist of two No. 4 rebars, one at the top and one at the bottom.
3. Retaining wall design may be based on the following drained parameters:

TABLE 2: RETAINING WALL DESIGN PARAMETERS

Parameter	Backfill Type	Value
Active Equivalent Fluid Pressure	Site Fill Materials	50 pcf
	Imported Sand/Gravel	35 pcf
At-Rest Equivalent Fluid Pressure	Site Fill Materials	65 pcf
	Imported Sand/Gravel	50 pcf

4. The site fill materials listed above exclude the fat clay soils which may not be used as wall backfill per the CBC. No surcharges are taken into consideration in the values presented in the previous paragraph. These values will require application of appropriate factors of safety, load factors, and/or other factors as deemed appropriate by the architect/engineer.
5. The active and at-rest pressures presented in Table 2 are applicable to a horizontal retained surface behind the wall. Walls having a retained surface that slopes upward from the wall should be designed for an additional equivalent fluid pressure of 1 pcf for the active case and 1.5 pcf for the at-rest case, for every degree of slope inclination.
6. Under the 2019 CBC, the Risk-Targeted Maximum Considered Earthquake (MCE_R) must be used for determining seismic pressures on walls. Further, Section 1807.2.2 of the 2019 CBC requires that dynamic seismic lateral earth pressures be provided by the geotechnical engineer for walls retaining more than 6 feet of backfill. As retaining walls for this project are not anticipated to exceed 6 feet in height, a seismic increment increase is not required.
7. Long-term settlement of properly compacted native soil retaining wall backfill or imported sand/gravel backfill should be assumed to be about 0.5 and 0.25 percent of the depth of the backfill, respectively. Improvements that are constructed near the tops of retaining walls should be designed to accommodate long-term settlement.



8. All retaining walls should be drained with perforated pipe encased in a free-draining gravel blanket. The pipe should be placed with perforations facing downward and should discharge in a nonerosive manner away from foundations and other improvements. The gravel blanket should have a width of approximately 1-foot and should extend upward to approximately 1-foot from the top of the wall backfill. The upper foot should be backfilled with native soil, except in areas where surface improvements will abut the top of the wall. In such cases, the gravel should extend to the imported nonexpansive material, aggregate base, or other material below the improved surface, as appropriate. To reduce infiltration of the soil into the gravel, a permeable synthetic filter fabric conforming to Standard Specifications Section 96-1.02B – Class C (Caltrans 2018), should be placed between the gravel and soil. Manufactured synthetic drains, such as Miradrain or Enkadrain are acceptable alternatives to the use of gravel, provided that they are installed in accordance with the recommendations of the manufacturer and Geotechnical Engineer.
9. Walls facing areas where moisture transmission through the wall would be undesirable should be thoroughly waterproofed in accordance with the specifications of the architect/engineer.
10. The architect/engineer should bear in mind that retaining walls by their nature are flexible structures, and that surface treatments on walls often crack. Where walls are to be plastered or otherwise have a finish applied, the flexibility should be considered in determining the suitability of the surfacing material, spacing of horizontal and vertical control joints, etc. The flexibility should also be considered where a retaining wall will abut or be connected to a rigid structure, and where the geometry of the wall is such that its flexibility will vary along its length.

Vehicular Pavement Sections

HMA Pavement

The following HMA pavement sections are based upon a tested R-value of 6 from adjacent projects, and assumed Traffic Indices (TIs) of 4.0 through 7.0. Determination of the appropriate TI for specific areas of the project is left to others. The HMA sections were calculated in accordance with the method presented in the “Highway Design Manual” (Caltrans 2018). The



calculated HMA and Class 2 aggregate base (AB) thicknesses are for compacted material. Normal Caltrans construction tolerances should apply.

TABLE 3: HMA Pavement Sections

Traffic Index	HMA (in)	Class 2 AB (in)
4.0	2.25	8.0
4.5	2.50	9.0
5.0	2.75	10.5
5.5	3.00	12.0
6.0	3.25	12.0
6.5	3.75	14.0
7.0	4.00	15.5

*Per Caltrans (2018) Section 26

PCC Pavement

1. If unreinforced Portland cement concrete pavement is planned, the following minimum section is recommended:
 - 8 inches plain PCC (4,000 psi minimum)
 - Joint spacing at a maximum of 12 feet on-center each way
 - #4 smooth joint dowels at 10-inch centers
 - 12 inches Class 2 AB and subgrade compacted to a minimum of 95 percent of maximum dry density
2. If reinforced concrete pavement is planned, the following minimum section may be used:
 - 6 inches PCC (4,000 psi minimum)
 - Joint spacing at a maximum of 10 feet on-center each way
 - No. 4 rebar at 18-inch centers each way
 - No. 4 smooth joint dowels at 18-inch centers
 - 12 inches Class 2 AB and subgrade compacted to a minimum of 95 percent of maximum dry density



3. Alternately, the pavement may be designed by the architect/engineer for the appropriate loads. Provided that a minimum of 12 inches of AB compacted to a minimum of 95 percent of maximum dry density is provided, the design may be based on a subgrade modulus of 200 pci (psi/in). Specification of concrete properties and reinforcing is left to the architect/engineer.

Pavement Sections - General

1. HMA and PCC pavement should be constrained by curbs, gutters, flatwork, walls, etc.; free edges to the pavement should be avoided.
2. HMA and PCC pavement should be set back a minimum of 5 feet from any descending slope. Alternately, deepened curbs may be used to constrain the pavement. Where curbs will be deepened in lieu of the recommended setback, the individual situation should be reviewed, and specific recommendations prepared by the geotechnical engineer.
3. Subgrade and AB should be firm and unyielding when proof-rolled with heavy, rubber-tired grading equipment prior to continuing construction.
4. Finished pavement surfaces should be sloped to freely drain toward appropriate drainage facilities. Water should not be allowed to stand or pond on or adjacent to pavement, as it could cause premature pavement deterioration or improvement damage.
5. To reduce migration of surface drainage into the subgrade, maintenance of pavement areas is critical. Any cracks that develop in the pavement should be promptly sealed.
6. The local jurisdiction may have additional requirements for pavement or pavers that could take precedence over the above recommendations.

Drainage and Maintenance

1. Unpaved ground surfaces should be graded during construction and, per Section 1804.4 of the CBC, finish graded to direct surface runoff away from foundations, slopes, and other improvements at a minimum 5 percent grade for a minimum distance of 10 feet. If this is not feasible due to the terrain, property lines, or other factors, swales with improved surfaces, area drains, or other drainage features should be provided to divert drainage away from these areas.



2. Finished surfaces should be sloped to freely drain toward appropriate drainage facilities. Water should not be allowed to stand or pond on or adjacent to foundations.
3. All eaves of the proposed structures should be provided with roof gutters. Runoff from roof gutters, downspouts, area drains, weep holes, etc., should discharge to an appropriate outlet in a nonerosive manner away from foundations and other improvements in accordance with the requirements of the governing agencies. Erosion protection should be placed at all discharge points unless the discharge is to a pavement surface.
4. Stabilization of surface soils, particularly those disturbed during construction, by vegetation or other means *during and following construction*, should be implemented to protect the site from erosion damage. Care should be taken to establish and maintain vegetation.
5. Erosion protection should be maintained or supplemented as needed. Irrigation systems should be maintained so that the soils are not over-watered or allowed to desiccate.
6. To reduce the potential for damage due to erosion it is essential that the surface soils, particularly those disturbed during construction, be stabilized by vegetation or other means during and following construction. Care should be taken to establish and maintain vegetation. The landscaping and exterior flatwork should be installed to maintain the surface drainage recommended above.
7. To reduce the potential for disruption of drainage patterns and undermining of foundations and other improvements, rodent activity should be aggressively controlled.

Observation and Testing

1. It must be recognized that the recommendations contained in this report are based on a limited number of borings and rely on continuity of the subsurface conditions encountered. Therefore, the geotechnical engineer should be retained to provide consultation during the design phase, to review plans as they near completion, to interpret this report during construction, and to provide construction monitoring in the form of testing and observation.



2. At a minimum, the geotechnical engineer should be retained to provide:
 - Review of the project plans as they near completion
 - Professional observation during grading and backfill
 - Oversight of soil special inspection during grading and foundation construction

3. Special inspection of grading and backfill should be provided as per Section 1705.6 and Table 1705.6 of the 2019 CBC; the special inspector should be under the direction of the geotechnical engineer. It is our opinion that none of the grading construction is of a nature that should warrant continuous special inspection; periodic special inspection should suffice. Subject to approval by the Building Official, the exception to continuous special inspection is described in Section 1704.2 of the 2019 CBC and should be specified by the architect/engineer and periodic special inspection of the following items should be provided by the special inspector.
 - Stripping and clearing of vegetation and unsuitable materials
 - Overexcavation to the recommended depths
 - Scarification, moisture conditioning, and compaction of the soil
 - Fill quality, placement, and compaction
 - Utility trench backfill
 - Foundation excavations
 - Retaining wall drains and backfill
 - Subgrade and AB compaction and proof-rolling

4. A program of quality control should be developed prior to beginning grading. The contractor or project manager should determine any additional inspection items required by the architect/engineer or the governing jurisdiction.

5. Locations and frequency of compaction tests should be as per the recommendation of the geotechnical engineer at the time of construction. The recommended test locations and frequency may be subject to modification by the geotechnical engineer, based upon soil and moisture conditions encountered, size and type of equipment used by the contractor, the general trend of the results of compaction tests, or other factors.



6. A preconstruction conference among the owner, the geotechnical engineer, the governing agency, the special inspector, the project inspector, the architect/engineer, and contractors is recommended to discuss planned construction procedures and quality control requirements.
7. The geotechnical engineer should be notified at least 48 hours prior to beginning construction operations. If Earth Systems Pacific is not retained to provide construction observation and testing services, it shall not be responsible for the interpretation of the information by others or any consequences arising therefrom.

9.0 CLOSURE

Our intent was to perform the investigation in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the locality of this project and under similar conditions. No representation, warranty, or guarantee is either expressed or implied. This report is intended for the exclusive use by the client as discussed in the "Scope of Services" Section. Application beyond the stated intent is strictly at the user's risk.

This report is valid for conditions as they exist at this time for the type of project described herein. The conclusions and recommendations contained in this report could be rendered invalid, either in whole or in part, due to changes in building codes, regulations, standards of geotechnical or construction practice, changes in physical conditions, or the broadening of knowledge. If Earth Systems Pacific is not retained to provide construction observation and testing services, it shall not be responsible for the interpretation of the information by others or any consequences arising therefrom.

If changes with respect to project type or location become necessary, if items not addressed in this report are incorporated into plans, or if any of the assumptions used in the preparation of this report are not correct, this firm shall be notified for modifications to this report. Any items not specifically addressed in this report should comply with the CBC and the requirements of the governing jurisdiction.

The preliminary recommendations of this geotechnical report are based upon the geotechnical conditions encountered at the site and may be augmented by additional requirements of the architect/engineer, or by additional recommendations provided by the geotechnical engineer based on conditions exposed at the time of construction.



Cal Poly Tech Park II
Mount Bishop Road
San Luis Obispo, California

July 19, 2021

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Thank you for this opportunity to have been of service. If you have any questions, please feel free to contact this office at your convenience.

End of Text.



TECHNICAL REFERENCE LIST

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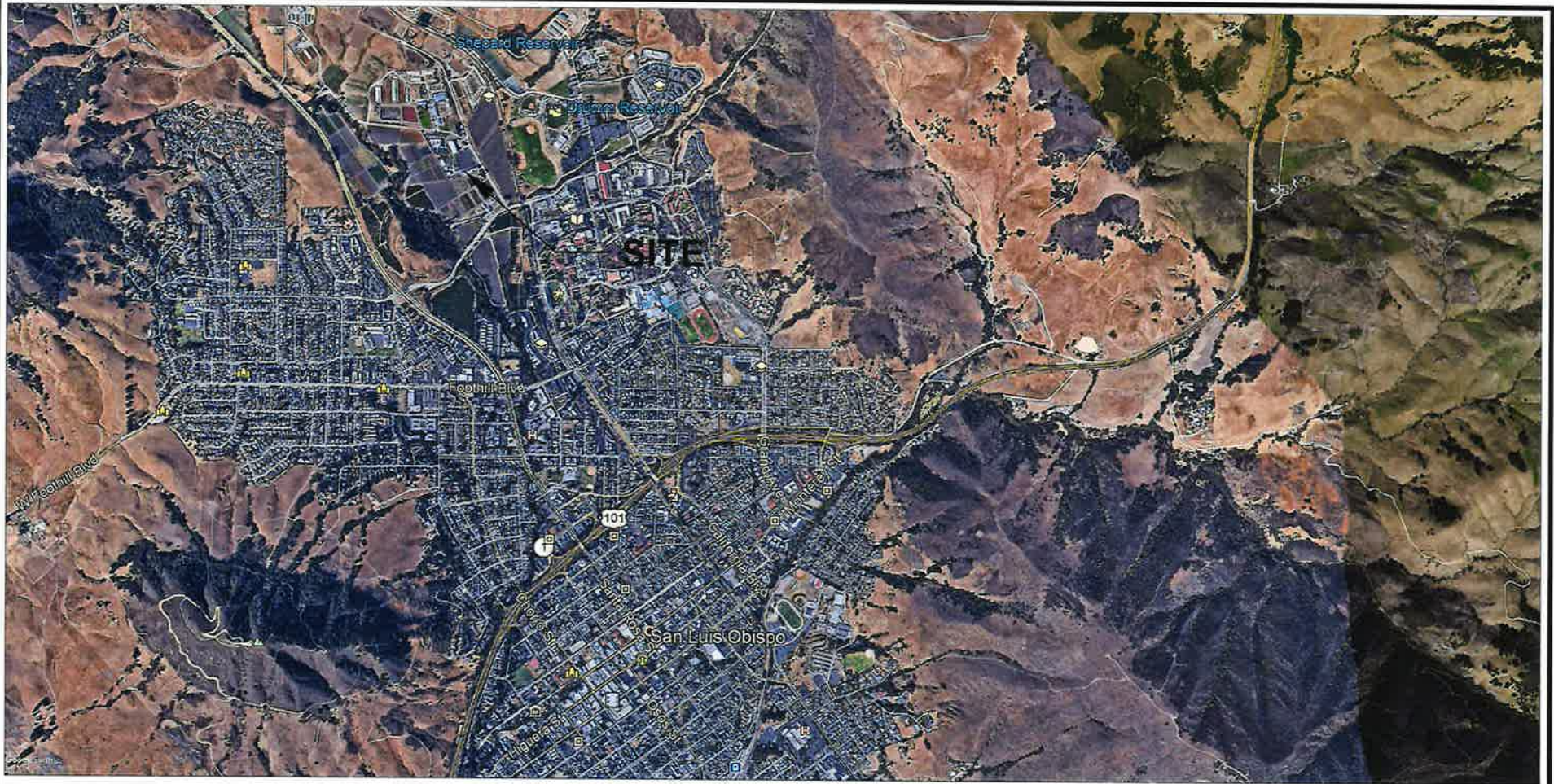
APPENDIX A

Site Vicinity Map

Exploration Location Map

Boring Log Legend

Boring Logs



BASE MAP PROVIDED BY: GOOGLE EARTH (2021)



NOT TO SCALE



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SITE VICINITY MAP
Cal Poly Tech Park
Mount Bishop Road
San Luis Obispo, California

Date
July 2021



Project No.
300986-048

Figure 1

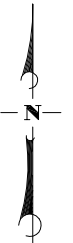
300986-048\CALPOLYTECHPARK\051821\mops.dwg



LEGEND

-  Boring Location (Approx.)
-  Infiltration Test Location (Approx.)

BASE MAP PROVIDED BY: GOOGLE EARTH (2021)



NOT TO SCALE



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EXPLORATION LOCATION MAP

Cal Poly Tech Park
 Mount Bishop Road
 San Luis Obispo, California

Date
 May 2021

Project No.
 300986-048

Figure 2



Earth Systems Pacific

BORING LOG LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

SAMPLE / SUBSURFACE WATER SYMBOLS		GRAPH. SYMBOL	MAJOR DIVISIONS	GROUP SYMBOL	TYPICAL DESCRIPTIONS	GRAPH. SYMBOL
CALIFORNIA MODIFIED		■	COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN #200 SIEVE SIZE	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
STANDARD PENETRATION TEST (SPT)		●		GP	POORLY GRADED GRAVELS, OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
SHELBY TUBE		□		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, NON-PLASTIC FINES	
BULK		○		GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, PLASTIC FINES	
SUBSURFACE WATER DURING DRILLING		▽		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
SUBSURFACE WATER AFTER DRILLING		▽		SP	POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES	
				SM	SILTY SANDS, SAND-SILT MIXTURES, NON-PLASTIC FINES	
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES, PLASTIC FINES	
			FINE GRAINED SOILS HALF OR MORE OF MATERIAL IS SMALLER THAN #200 SIEVE SIZE	ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
				MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
				PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	

OBSERVED MOISTURE CONDITION

DRY	SLIGHTLY MOIST	MOIST	VERY MOIST	WET (SATURATED)
-----	----------------	-------	------------	-----------------

CONSISTENCY

COARSE GRAINED SOILS			FINE GRAINED SOILS		
BLOWS/FOOT		DESCRIPTIVE TERM	BLOWS/FOOT		DESCRIPTIVE TERM
SPT	CA SAMPLER		SPT	CA SAMPLER	
0-10	0-16	LOOSE	0-2	0-3	VERY SOFT
11-30	17-50	MEDIUM DENSE	3-4	4-7	SOFT
31-50	51-83	DENSE	5-8	8-13	MEDIUM STIFF
OVER 50	OVER 83	VERY DENSE	9-15	14-25	STIFF
			16-30	26-50	VERY STIFF
			OVER 30	OVER 50	HARD

GRAIN SIZES

U.S. STANDARD SERIES SIEVE				CLEAR SQUARE SIEVE OPENING			
# 200	# 40	# 10	# 4	3/4"	3"	12"	
SILT & CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

TYPICAL BEDROCK HARDNESS

MAJOR DIVISIONS	TYPICAL DESCRIPTIONS
EXTREMELY HARD	CORE, FRAGMENT, OR EXPOSURE CANNOT BE SCRATCHED WITH KNIFE OR SHARP PICK; CAN ONLY BE CHIPPED WITH REPEATED HEAVY HAMMER BLOWS
VERY HARD	CANNOT BE SCRATCHED WITH KNIFE OR SHARP PICK; CORE OR FRAGMENT BREAKS WITH REPEATED HEAVY HAMMER BLOWS
HARD	CAN BE SCRATCHED WITH KNIFE OR SHARP PICK WITH DIFFICULTY (HEAVY PRESSURE); HEAVY HAMMER BLOW REQUIRED TO BREAK SPECIMEN
MODERATELY HARD	CAN BE GROOVED 1/16 INCH DEEP BY KNIFE OR SHARP PICK WITH MODERATE OR HEAVY PRESSURE; CORE OR FRAGMENT BREAKS WITH LIGHT HAMMER BLOW OR HEAVY MANUAL PRESSURE
SOFT	CAN BE GROOVED OR GOUGED EASILY BY KNIFE OR SHARP PICK WITH LIGHT PRESSURE, CAN BE SCRATCHED WITH FINGERNAIL; BREAKS WITH LIGHT TO MODERATE MANUAL PRESSURE
VERY SOFT	CAN BE READILY INDENTED, GROOVED OR GOUGED WITH FINGERNAIL, OR CARVED WITH KNIFE; BREAKS WITH LIGHT MANUAL PRESSURE

TYPICAL BEDROCK WEATHERING

MAJOR DIVISIONS	TYPICAL DESCRIPTIONS
UNWEATHERED	NO DISCOLORATION, NOT OXIDIZED
SLIGHTLY WEATHERED	DISCOLORATION OR OXIDATION IS LIMITED TO SURFACE OF, OR SHORT DISTANCE FROM, FRACTURES; SOME FELDSPAR CRYSTALS ARE DULL
MODERATELY WEATHERED	DISCOLORATION OR OXIDATION EXTENDS FROM FRACTURES, USUALLY THROUGHOUT; Fe-Mg MINERALS ARE "RUSTY", FELDSPAR CRYSTALS ARE "CLOUDY"
HIGHLY WEATHERED	DISCOLORATION OR OXIDATION THROUGHOUT; FELDSPAR AND Fe-Mg MINERALS ARE ALTERED TO CLAY TO SOME EXTENT, OR CHEMICAL ALTERATION PRODUCES IN SITU DISAGGREGATION
DECOMPOSED	DISCOLORATION OR OXIDATION THROUGHOUT, BUT RESISTANT MINERALS SUCH AS QUARTZ MAY BE UNALTERED; FELDSPAR AND Fe-Mg MINERALS ARE COMPLETELY ALTERED TO CLAY

drafting/masters/Boring Log Legend 052719.dwg



LOGGED BY: K. Koo
 DRILL RIG: Mobile B-53 with Automatic Hammer
 AUGER TYPE: 6" Hollow Stem

PAGE 1 OF 1
 JOB NO.: 300986-048
 DATE: 5/18/2021

DEPTH (feet)	USCS CLASS	SYMBOL	SAMPLE DATA					
			INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.	
Cal Poly Tech Park II Mount Bishop Road San Luis Obispo, California								
SOIL DESCRIPTION								
0 - 1 - 2 - 3 - 4	SC		CLAYEY SAND: dark brown, medium dense, moist (Alluvium)	0.0 - 4.0	○			
4 - 5 - 6 - 7 - 8	GP		POORLY GRADED GRAVEL: gray, dense, moist	5.0 - 6.5 4.0 - 8.0	■ ○	111.9	4.0	10 21 32
8 - 9 - 10 - 11 - 12 - 13 - 14	CL		SANDY LEAN CLAY: dark brown, hard, moist	10.0 - 11.5	■	106.8	20.7	7 22 36
15 - 16	CL		SANDY LEAN CLAY: orange brown, very stiff, very moist (Residual Soil)	15.0 - 16.5	●			4 10 17
17 - 18 - 19 - 20 - 21 - 22 - 23 - 24 - 25 - 26			End of Boring @ 16.5' No subsurface water encountered					

LEGEND: ■ Ring Sample ○ Grab Sample □ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.



LOGGED BY: K. Koo
 DRILL RIG: Mobile B-53 with Automatic Hammer
 AUGER TYPE: 6" Hollow Stem

PAGE 1 OF 1
 JOB NO.: 300986-048
 DATE: 5/18/2021

DEPTH (feet)	USCS CLASS	SYMBOL	SAMPLE DATA						
			INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.		
Cal Poly Tech Park II Mount Bishop Road San Luis Obispo, California									
SOIL DESCRIPTION									
0	CH		SANDY FAT CLAY: dark brown, medium stiff, slightly moist (Alluvium)	0.0 - 7.0	○				
1									
2									
3									
4									
5					5.0 - 6.5	■	78.0	16.7	11 13 25
6									
7			SANDSTONE: tan, moderately hard, slightly moist, slightly weathered (Franciscan Mélange)						
8									
9									
10				10.0 - 10.5	●			50(2)	
11									
12									
13									
14									
15			15.0 - 15.5	●			50(2)		
16			End of Boring @ 15.5' No subsurface water encountered						
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									


LEGEND: ■ Ring Sample ○ Grab Sample □ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.



LOGGED BY: K. Koo
 DRILL RIG: Mobile B-53 with Automatic Hammer
 AUGER TYPE: 6" Hollow Stem

PAGE 1 OF 1
 JOB NO.: 300986-048
 DATE: 5/18/2021


DEPTH (feet)	USCS CLASS	SYMBOL	SAMPLE DATA					
			INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.	
Cal Poly Tech Park II Mount Bishop Road San Luis Obispo, California								
SOIL DESCRIPTION								
0	CL							
1								
2								
3								
4								
5			5.0 - 5.5	●				50(2)
6								
End of Boring @ 5.5' No subsurface water encountered								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

LEGEND:  Ring Sample  Grab Sample  Shelby Tube Sample  SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.



LOGGED BY: K. Koo
 DRILL RIG: Mobile B-53 with Automatic Hammer
 AUGER TYPE: 6" Hollow Stem

DEPTH (feet)	USCS CLASS	SYMBOL	SAMPLE DATA				
			INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
Cal Poly Tech Park II Mount Bishop Road San Luis Obispo, California							
SOIL DESCRIPTION							
0	CL						
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							

LEGEND:  Ring Sample  Grab Sample  Shelby Tube Sample  SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.




LOGGED BY: K. Koo

DRILL RIG: Mobile B-53 with Automatic Hammer

JOB NO.: 300986-048

AUGER TYPE: 6" Hollow Stem

DATE: 5/18/2021

DEPTH (feet)	USCS CLASS	SYMBOL	SAMPLE DATA				
			INTERVAL (feet)	SAMPLE TYPE	DRY DENSITY (pcf)	MOISTURE (%)	BLOWS PER 6 IN.
Cal Poly Tech Park II Mount Bishop Road San Luis Obispo, California							
SOIL DESCRIPTION							
0	CL		SANDY LEAN CLAY: dark brown, moderately stiff, moist				
1							
2			SANDSTONE: light brown, moderately hard, slightly moist, moderately hard				
3							
4			End of Boring @ 5.0' No subsurface water encountered				
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							

LEGEND: ■ Ring Sample ○ Grab Sample □ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

APPENDIX B

Laboratory Test Results



Cal Poly Tech Park

300986-048

BULK DENSITY TEST RESULTS

ASTM D 2937-17 (modified for ring liners)

June 3, 2021

BORING NO.	DEPTH feet	MOISTURE CONTENT, %	WET DENSITY, pcf	DRY DENSITY, pcf
1	6.0 - 6.5	4.0	116.4	111.9
1	11.0 - 11.5	20.7	128.8	106.8
2	6.0 - 6.5	9.2	103.3	94.6

EXPANSION INDEX TEST RESULTS

ASTM D 4829-19

BORING NO.	DEPTH feet	EXPANSION INDEX
1	0.0 - 4.0	44
2	0.0 - 7.0	83



PARTICLE SIZE ANALYSIS

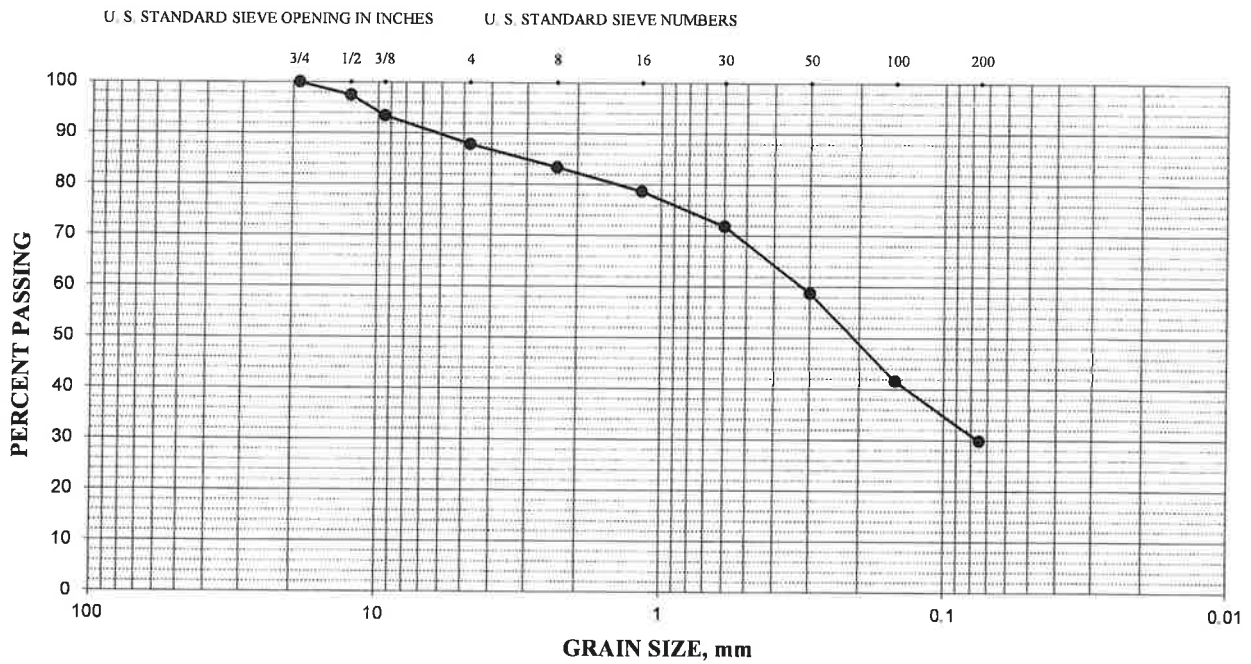
ASTM D 422-63/07; D 1140-017

Boring #1 @ 0.0 - 4.0'

June 3, 2021

Clayey Sand (SC)

Sieve size	% Retained	% Passing
3/4" (19-mm)	0	100
1/2" (12.5-mm)	3	97
3/8" (9.5-mm)	7	93
#4 (4.75-mm)	12	88
#8 (2.36-mm)	17	83
#16 (1.18-mm)	21	79
#30 (600- μ m)	28	72
#50 (300- μ m)	41	59
#100 (150- μ m)	58	42
#200 (75- μ m)	70	30





MOISTURE-DENSITY COMPACTION TEST

ASTM D 1557-12 (Modified)

PROCEDURE USED: B

June 3, 2021

PREPARATION METHOD: Moist

Boring #1 @ 0.0 - 4.0'

RAMMER TYPE: Mechanical

Dark Brown Clayey Sand (SC)

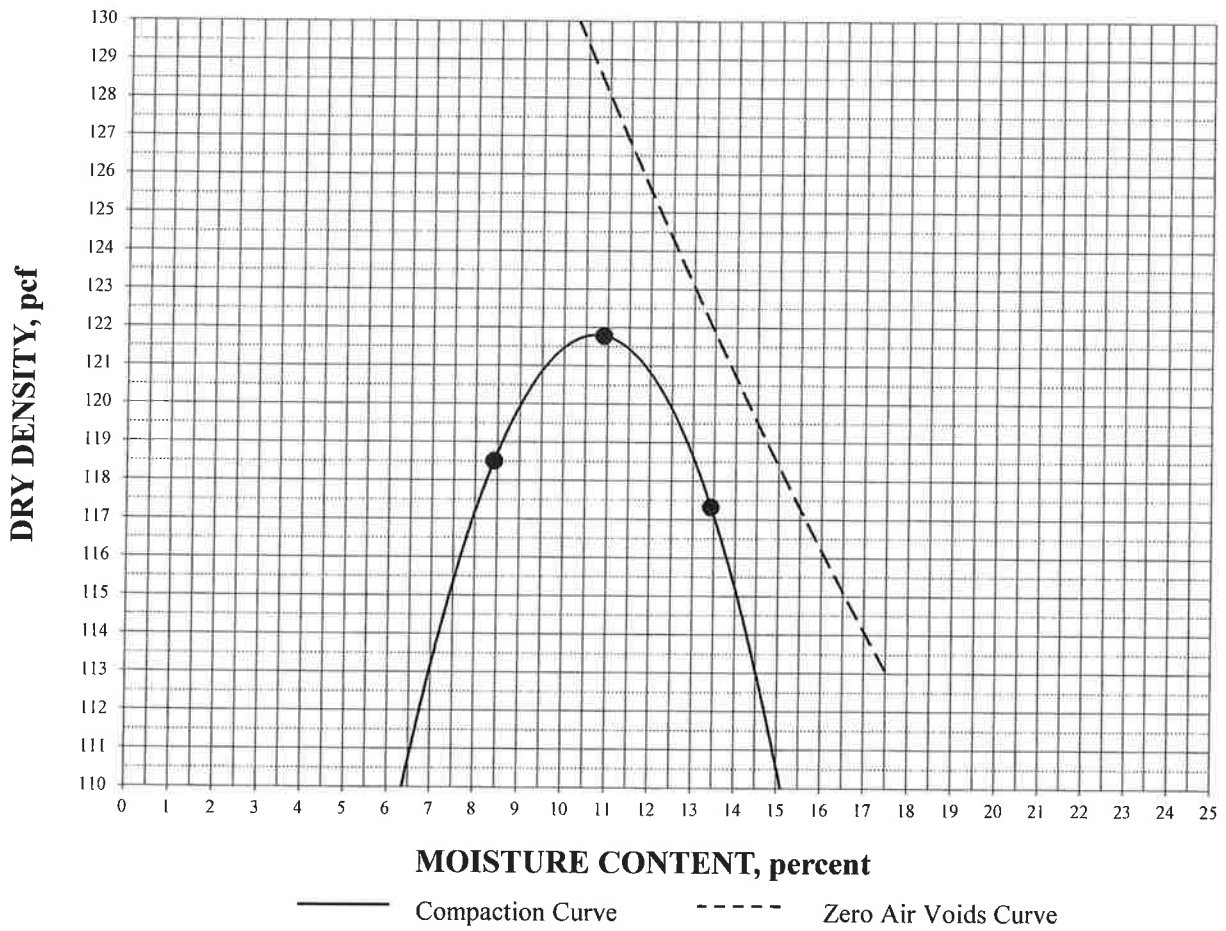
SPECIFIC GRAVITY: 2.65 (assumed)

SIEVE DATA:

Sieve Size	% Retained (Cumulative)
3/4"	0
3/8"	7
#4	12

MAXIMUM DRY DENSITY: 121.8 pcf

OPTIMUM MOISTURE: 10.7%





DIRECT SHEAR

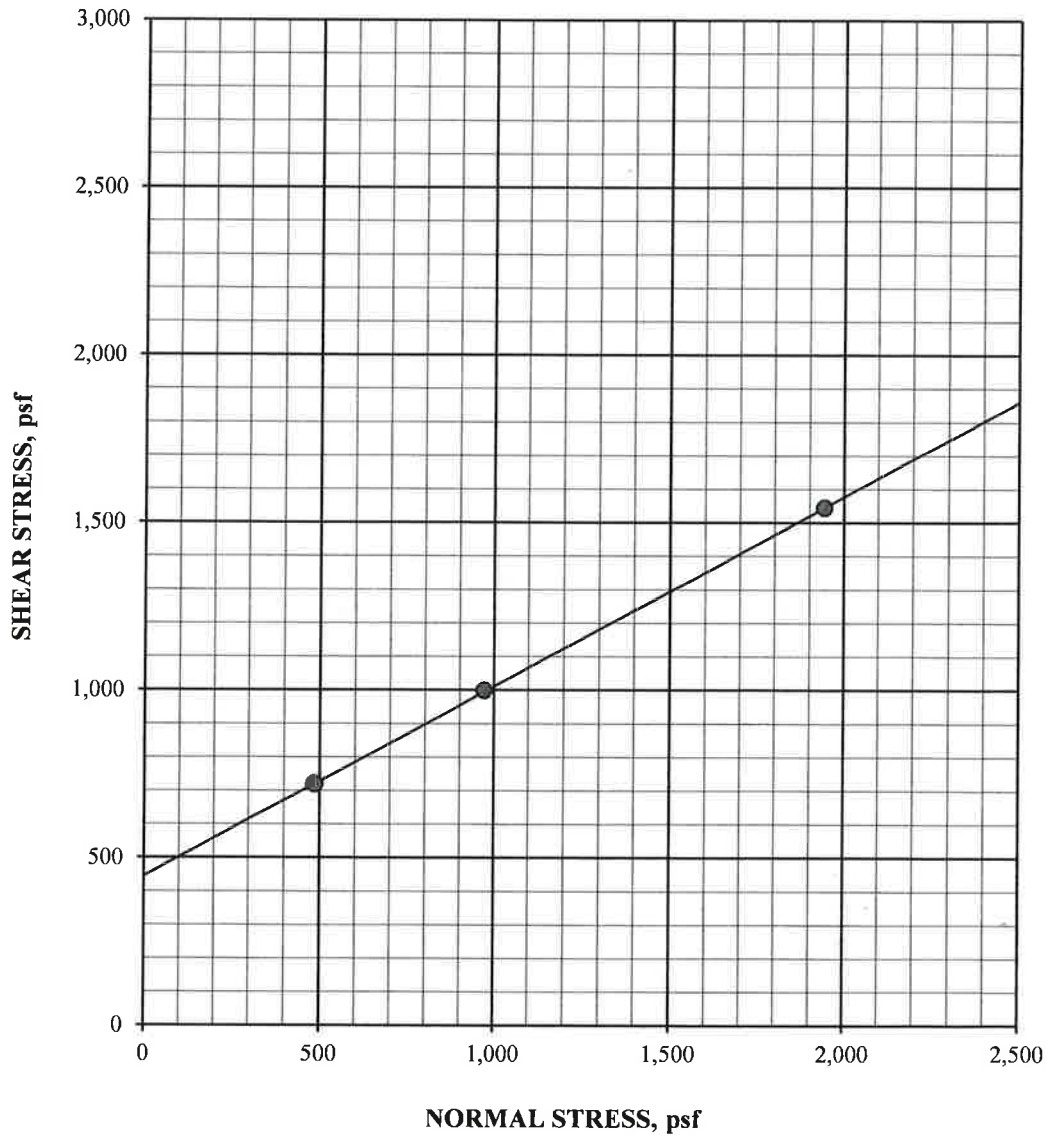
ASTM D 3080/D3080M-11⁵ (modified for consolidated, undrained conditions)

June 3, 2021

Boring #1 @ 0.0 - 4.0'
Clayey Sand (SC)
Compacted to 90% RC, saturated

INITIAL DRY DENSITY: 109.6 pcf
INITIAL MOISTURE CONTENT: 10.7 %
PEAK SHEAR ANGLE (ϕ): 30°
COHESION (C): 446 psf

SHEAR vs. NORMAL STRESS





Cal Poly Tech Park

300986-048

DIRECT SHEAR continued

ASTM D 3080/D3080M-11⁵ (modified for consolidated, undrained conditions)

Boring #1 @ 0.0 - 4.0'

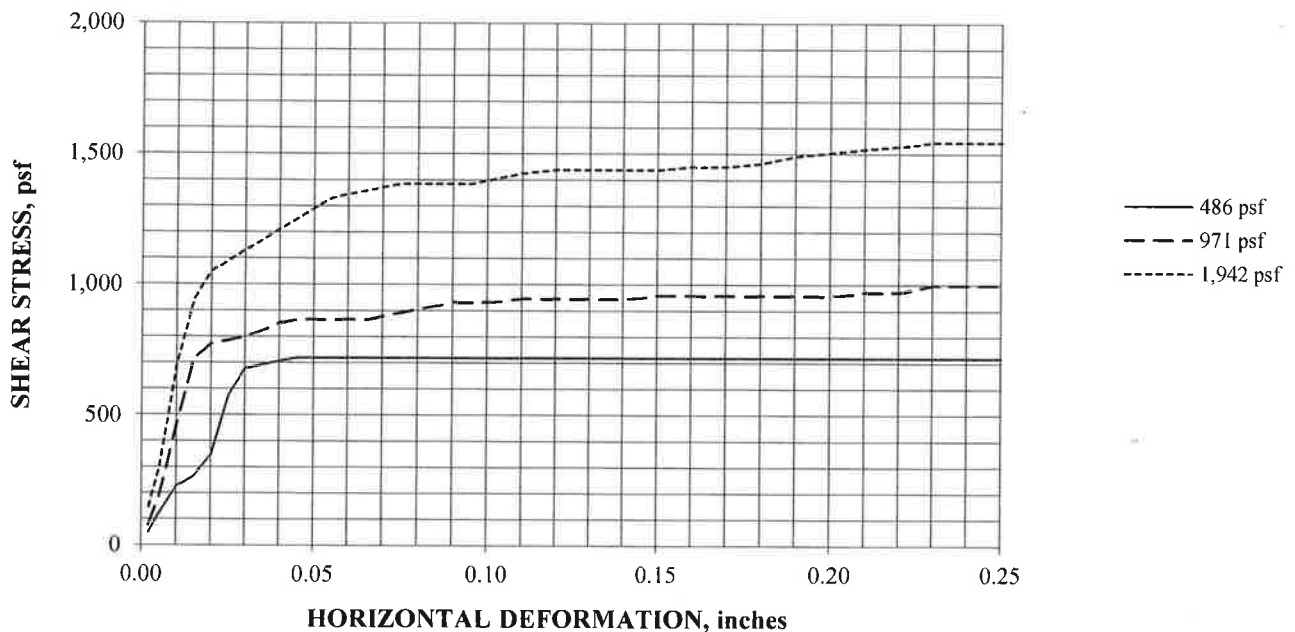
June 3, 2021

Clayey Sand (SC)

Compacted to 90% RC, saturated

SPECIFIC GRAVITY: 2.65 (assumed)

SAMPLE NO.:	1	2	3	AVERAGE
INITIAL				
WATER CONTENT, %	10.7	10.7	10.7	10.7
DRY DENSITY, pcf	109.6	109.6	109.6	109.6
SATURATION, %	55.8	55.8	55.8	55.8
VOID RATIO	0.508	0.508	0.508	0.508
DIAMETER, inches	2.410	2.410	2.410	2.410
HEIGHT, inches	1.00	1.00	1.00	1.00
AT TEST				
WATER CONTENT, %	23.0	23.3	22.7	
DRY DENSITY, pcf	111.2	113.4	115.0	
SATURATION, %	100.0	100.0	100.0	
VOID RATIO	0.487	0.459	0.438	
HEIGHT, inches	0.99	0.97	0.95	





PARTICLE SIZE ANALYSIS

ASTM D 422-63/07; D 1140-017

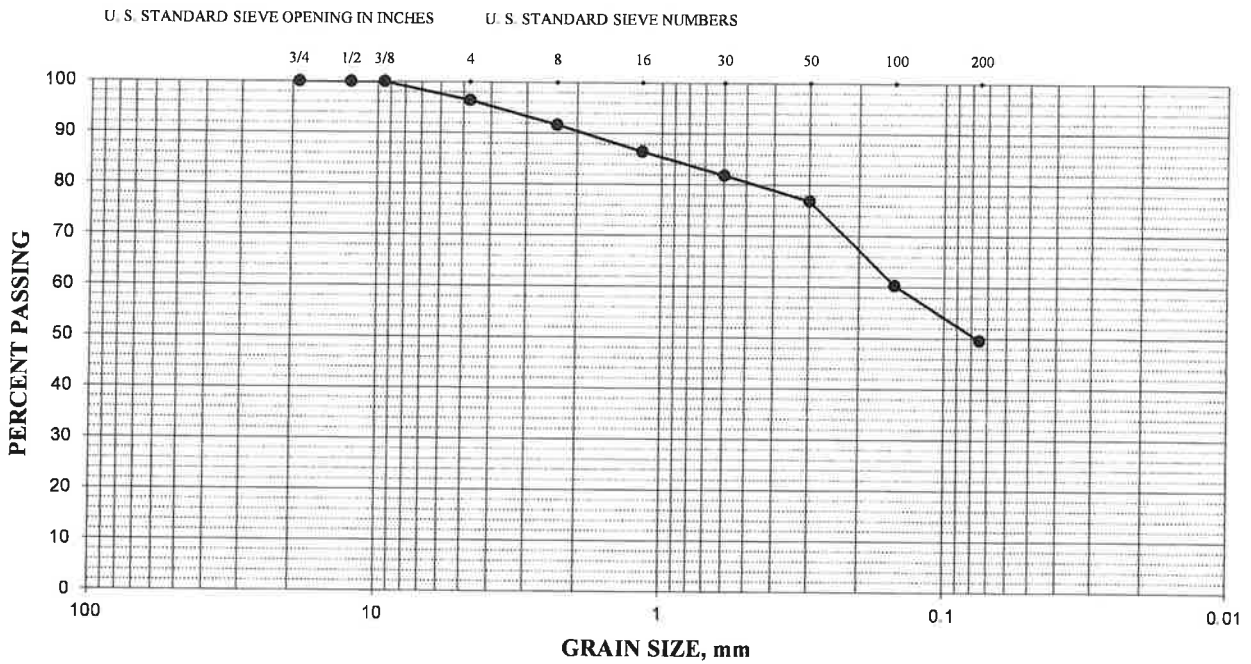
Boring #2 @ 0.0 - 7.0'

June 3, 2021

Sandy Fat Clay (CH)

LL = 50; PL = 14; PI = 36

Sieve size	% Retained	% Passing
3/4" (19-mm)	0	100
1/2" (12.5-mm)	0	100
3/8" (9.5-mm)	0	100
#4 (4.75-mm)	4	96
#8 (2.36-mm)	8	92
#16 (1.18-mm)	14	86
#30 (600- μ m)	18	82
#50 (300- μ m)	23	77
#100 (150- μ m)	40	60
#200 (75- μ m)	50	50





MOISTURE-DENSITY COMPACTION TEST

ASTM D 1557-12 (Modified)

PROCEDURE USED: A

June 3, 2021

PREPARATION METHOD: Moist

Boring #2 @ 0.0 - 7.0'

RAMMER TYPE: Mechanical

Dark Brown Sandy Fat Clay (CH)

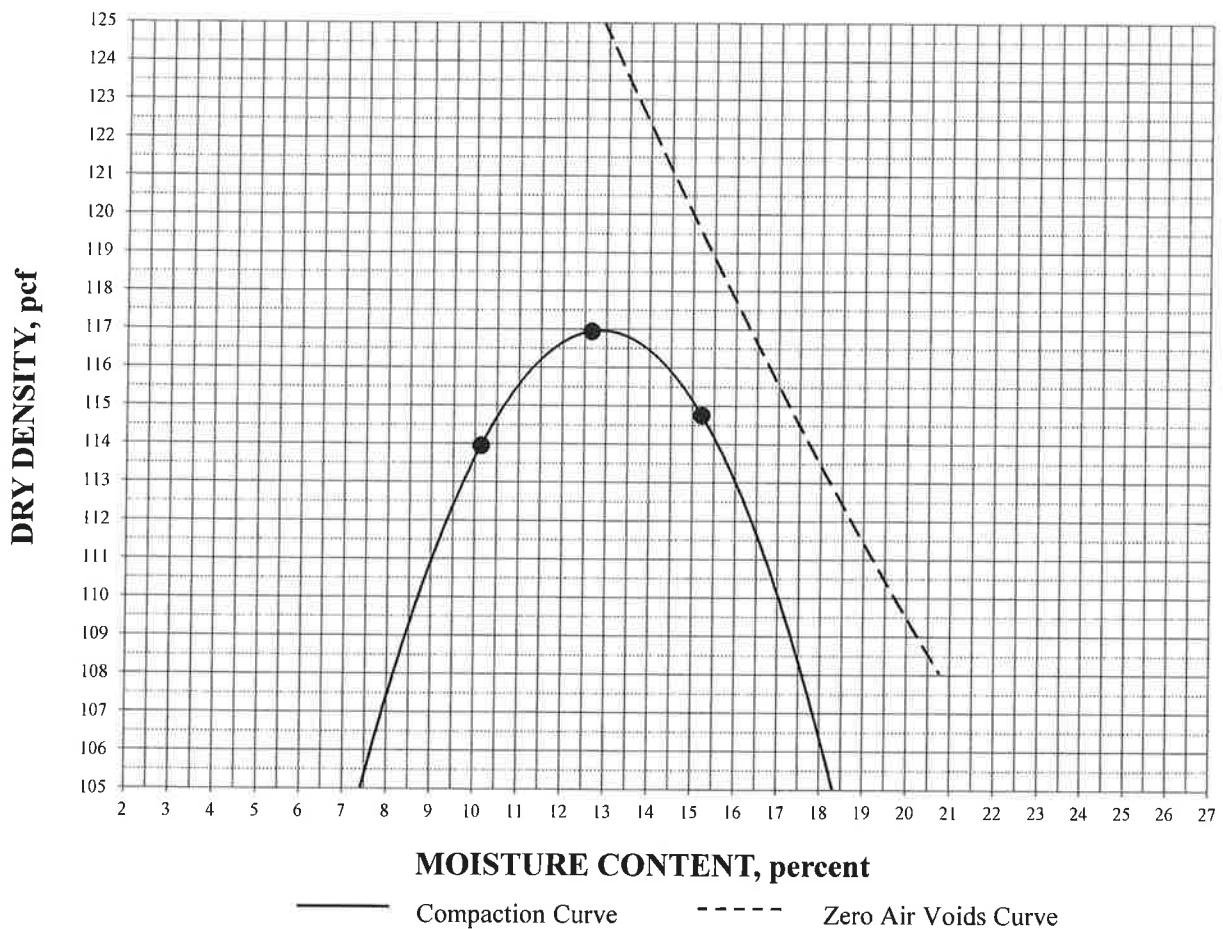
SPECIFIC GRAVITY: 2.70 (assumed)

SIEVE DATA:

Sieve Size	% Retained (Cumulative)
3/4"	0
3/8"	0
#4	4

MAXIMUM DRY DENSITY: 117.0 pcf

OPTIMUM MOISTURE: 12.9%





Cal Poly Tech Park

300986-048

DIRECT SHEAR

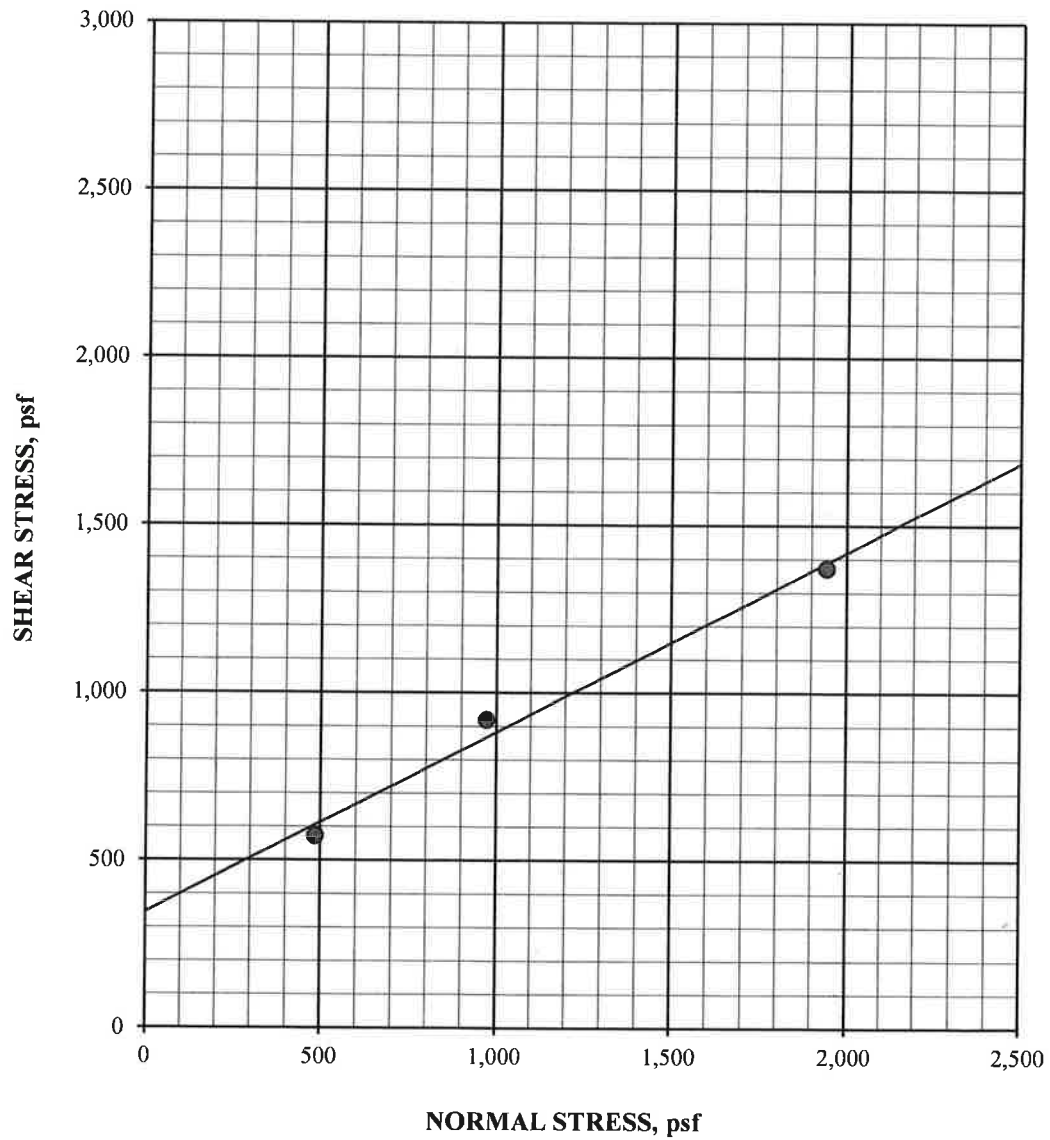
ASTM D 3080/D3080M-11⁵ (modified for consolidated, undrained conditions)

June 3, 2021

Boring #2 @ 0.0 - 7.0'
Sandy Fat Clay (CH)
Compacted to 90% RC, saturated

INITIAL DRY DENSITY: 105.3 pcf
INITIAL MOISTURE CONTENT: 12.7 %
PEAK SHEAR ANGLE (ϕ): 28°
COHESION (C): 346 psf

SHEAR vs. NORMAL STRESS





DIRECT SHEAR continued

ASTM D 3080/D3080M-11⁵ (modified for consolidated, undrained conditions)

Boring #2 @ 0.0 - 7.0'

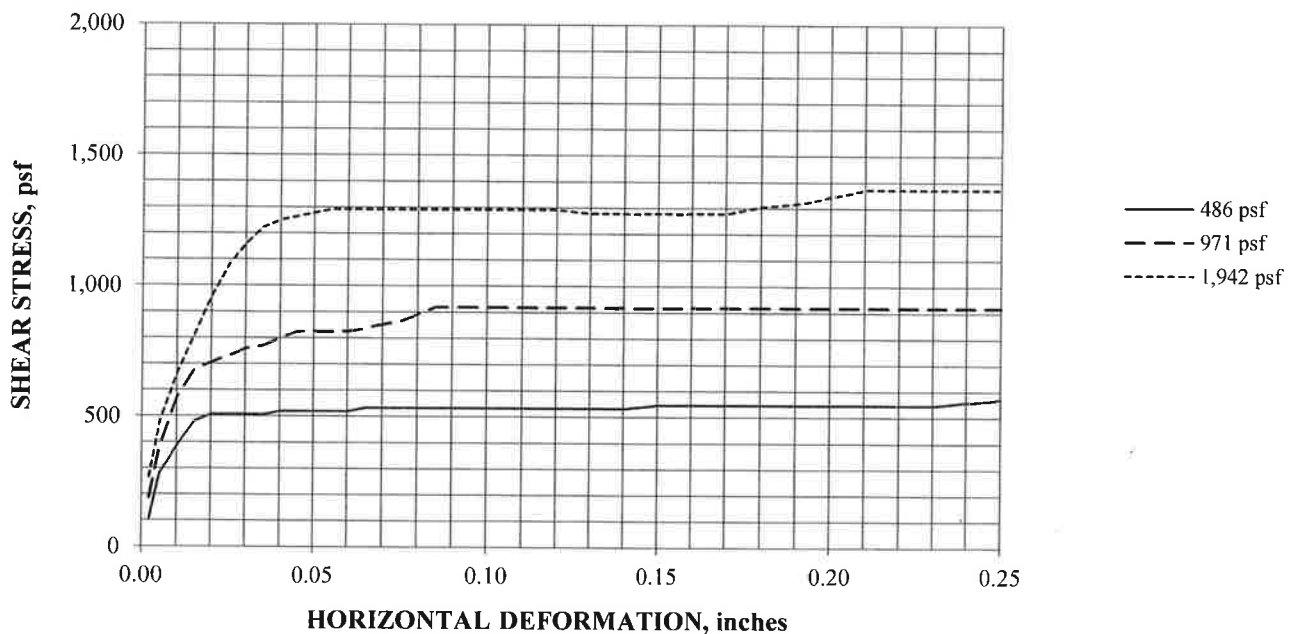
June 3, 2021

Sandy Fat Clay (CH)

Compacted to 90% RC, saturated

SPECIFIC GRAVITY: 2.70 (assumed)

SAMPLE NO.:	1	2	3	AVERAGE
INITIAL				
WATER CONTENT, %	12.7	12.7	12.7	12.7
DRY DENSITY, pcf	105.3	105.3	105.3	105.3
SATURATION, %	57.1	57.1	57.1	57.1
VOID RATIO	0.601	0.601	0.601	0.601
DIAMETER, inches	2.410	2.410	2.410	
HEIGHT, inches	1.00	1.00	1.00	
AT TEST				
WATER CONTENT, %	25.0	26.0	27.5	
DRY DENSITY, pcf	106.7	108.2	110.5	
SATURATION, %	100.0	100.0	100.0	
VOID RATIO	0.580	0.557	0.525	
HEIGHT, inches	0.99	0.97	0.95	





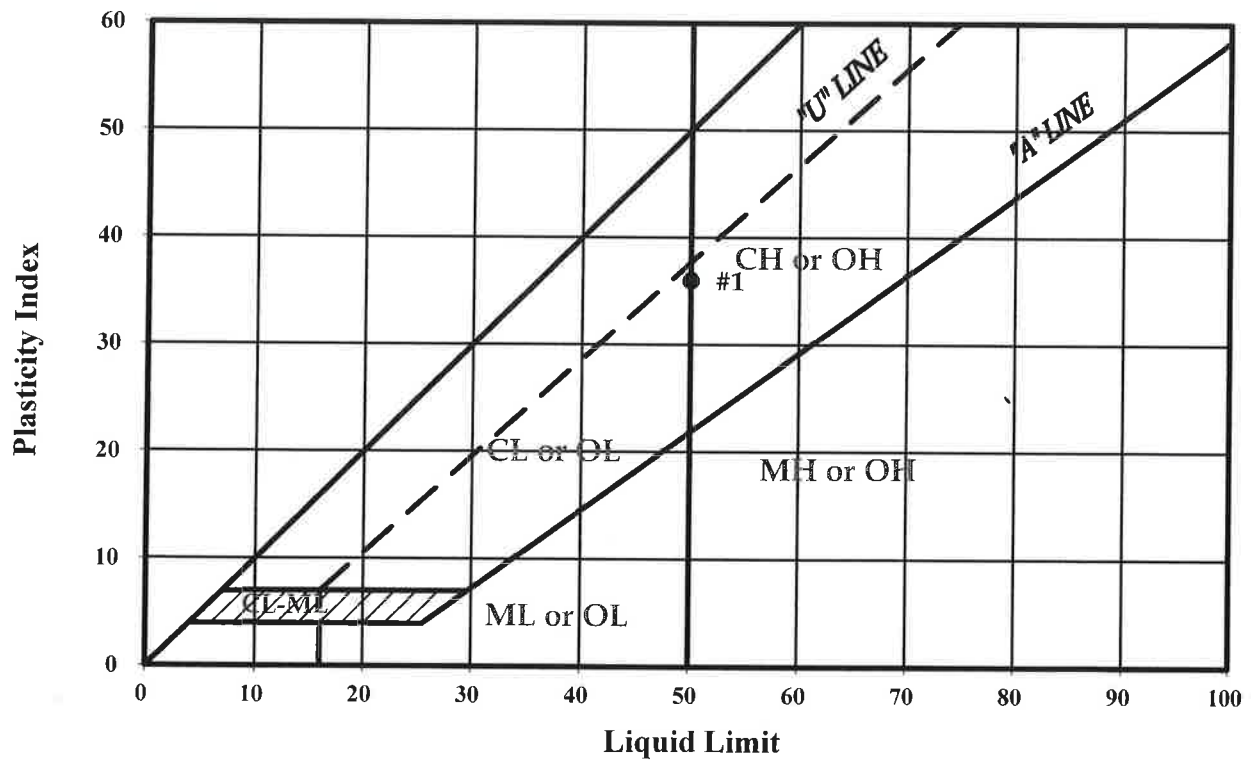
PLASTICITY INDEX

ASTM D 4318-17

June 3, 2021

Test No.:	1	2	3	4	5
Boring No.:	2				
Sample Depth:	0.0 - 7.0'				
Liquid Limit:	50				
Plastic Limit:	14				
Plasticity Index:	36				

Plasticity Chart





Cal Poly Tech Park

300986-048

EXPANSION INDEX TEST RESULTS

ASTM D 4829-19

BORING NO.	DEPTH feet	EXPANSION INDEX
1	0.0 - 4.0	44
2	0.0 - 7.0	83

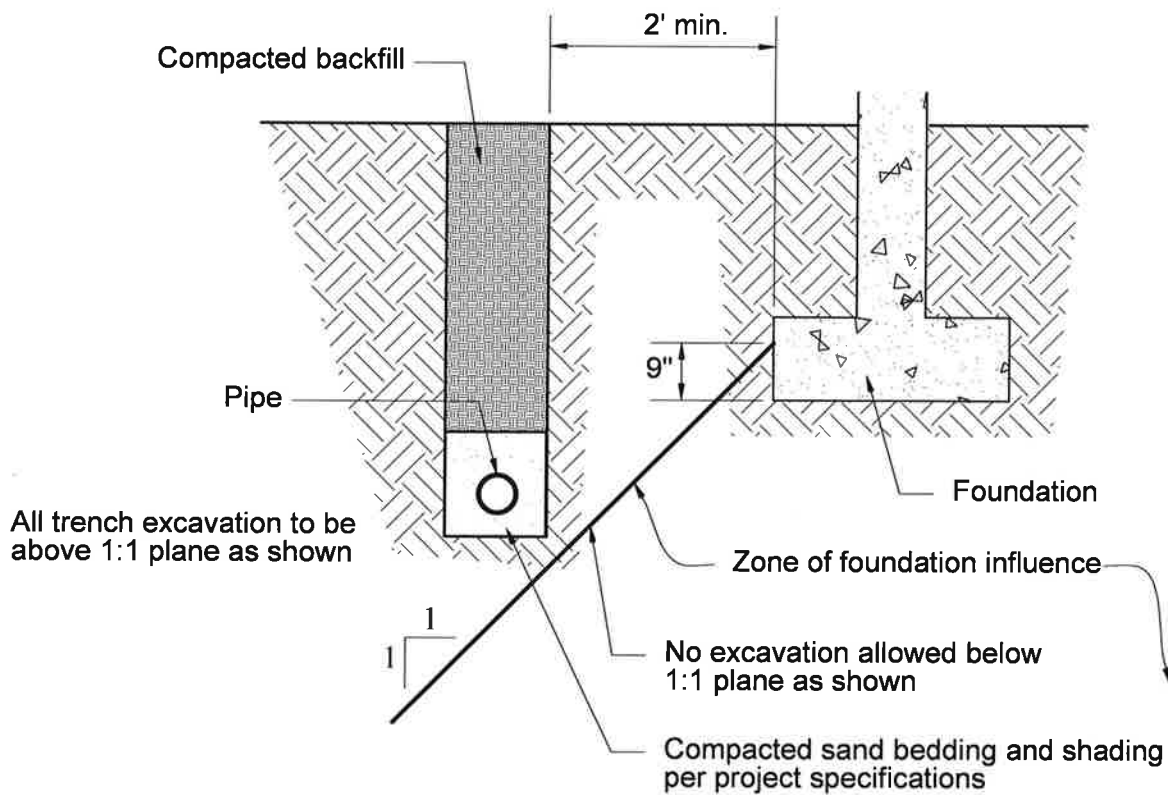
APPENDIX C

LID Infiltration Test Results

APPENDIX D

Typical Detail A: Pipe Placed Parallel to Foundation

TYPICAL DETAIL A PIPE PLACED PARALLEL TO FOUNDATIONS



SCHEMATIC ONLY
NOT TO SCALE



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