



# Project Specification Manual

## Volume 2

### Sierra Madre Library Redesign and Improvements Sierra Madre, CA Project Number: FC82306



**SUBMITTAL TYPE: BIDDING DOCUMENTS**

**ISSUE DATE: JULY 17, 2024**



316 West 2nd Street | Penthouse | Los Angeles, CA 90012  
TSK Project Number: 23-025.00

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**SECTION 21 13 13 – FIRE SUPPRESSION SPRINKLER SYSTEM**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Fire sprinkler system for protection of buildings.
- B. Related Requirements: The requirements of this Section, NFPA 13 shall take precedence over requirements found in the following:
  - 2. Division 01 - General Requirements.

**1.02 SUBMITTALS**

- A. Manufacturer's Data:
  - 1. Submit a complete and detailed equipment and material list of items to be furnished and installed under this section.
  - 2. Submit the manufacturer's specifications and other data required to demonstrate compliance with the plans and specified requirements.
- B. Drawings:
  - 1. Submit shop drawings of wet pipe fire protection sprinkler systems in compliance with NFPA 13, Standard for the Installation of Sprinkler Systems, Sprinkler systems shall comply with the provisions of NFPA 13.
  - 2. Shop drawings shall fully comply with the most stringent provisions of this specification and plans, and with the applicable codes and standards.
  - 3. Shop drawings shall be the same size as the Contract Drawings and shall be produced using AutoCAD.
- C. Regulatory Requirements:
  - 1. Installation of the fire sprinkler system shall not vary from the plans unless alterations have been approved by the State Fire Marshal at DSA.
  - 2. Complete DSA standard testing forms and get sign-off by the Project Inspector.
- D. Closeout Submittals: Submit in accordance with Section 01 7700, Contract Closeout, and as specified herein:
  - 1. Record Drawings:

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## **City of Sierra Madre Library Expansion**

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- a. Record drawings of installed Work shall be maintained current on the Project site, available for the Fire Marshal and the Project Inspector to review.
- b. At completion of installation submit Record Drawings signed by the installing Contractor in AutoCAD format, including:
  - 1) Record Specifications.
  - 2) Record Product Data: Include specific model, type and size for equipment and material installed.
  - 3) Record Test Results.
  - 4) Maintenance Manuals.

### **1.03 QUALITY ASSURANCE**

- A. Comply with applicable national or local codes and standards.
- B. Except where exceeded by the requirements of these specifications, the following are made part of this section: prints and details, and provisions of the NFPA 13 Standard for Installation of Sprinkler Systems.
- C. Qualifications of Manufacturer: Products used in work of this section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a 5-year history of successful production that is acceptable to the Architect.
- D. Qualifications of Installer: The Installer shall have a current C-16 license in the State of California in the installation of fire sprinkler systems.

### **1.04 COORDINATION**

- A. Coordinate activities in accordance with provisions of Section 22 0500.

### **1.05 JOB CONDITIONS**

- A. Unscheduled utility flow interruptions are not permitted. Schedule service interruptions in advance, with the OAR.

### **1.06 EXTRA MATERIALS FOR MAINTENANCE**

- A. Provide spare sprinkler heads in a quantity equal to 2 percent of the total number of each type of sprinkler head installed. There shall be no less than two heads of each type and temperature rating provided and in no case less than six spare sprinkler heads per building. There shall be no fewer than 6 spare sprinkler heads for up to 300 sprinkler heads installed; no less than 12 spare sprinkler heads for up to 1,000 sprinkler heads installed; and no less than 24 spare sprinkler heads for the sites with more than 1,000 sprinkler heads installed. Spare sprinkler heads shall be kept inside of spare sprinkler head box(s). A spare sprinkler wrench for each type of sprinkler head shall also be provided inside of each spare sprinkler head box, at each building. Locations of spare sprinkler boxes shall be located at:
  1. Fire Sprinkler Riser, when enclosed and secure.
  2. Plant Manager's Office, when the Fire Sprinkler Riser is exposed.'

## **PART 2 - PRODUCTS**

### **FIRE SUPPRESSION SPRINKLER SYSTEM - 211313**

## **2.01 FIRE PROTECTION SYSTEM DESCRIPTION**

- A. General: Provide systems complete including, but not limited to:
  - 1. Provide underground and above-ground sprinkler and standpipe piping including trenching and backfilling. Materials and equipment shall be UL/FM listed and approved as required by NFPA for their application. Required signage shall be provided and installed as required by NFPA 13.
  - 2. Provide overhead sprinkler system with sprinklers installed as required according to type, location, and temperature rating.
- B. Sprinkler Heads:
  - 1. Provide chrome pendant spray type sprinkler heads with matching escutcheons in areas with finished ceilings. Exterior escutcheons shall be poly-coated or concealed type to prevent rusting and oxidation.
  - 2. Provide upright sprinklers in areas with exposed piping.
  - 3. Provide poly-coated glass bulb corrosion resistance type sprinkler heads in areas exposed to a corrosive environment such as parking garages and coastal air.
  - 4. Sprinklers shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation,
  - 5. Sprinklers in concealed spaces, exterior locations, and other areas that will experience over 100 degrees F ambient temperature shall be furnished with 200 to 225 degree rated sprinklers. Sprinkler heads in boiler rooms, furnace rooms, or heater rooms shall be furnished with sprinklers rated at 250 to 290 degrees F. If a sprinkler is directly affected by a spotlight, steam, or other heat sources, a 350 degree F or higher sprinkler head shall be furnished. Sprinkler heads in other locations, unless otherwise noted, shall be 155 to 165 degrees F rated.
  - 6. Automatic fire sprinkler head type shall be as follows:
    - a. In areas with ceiling heights of nine feet or lower, sprinkler heads installed shall be recessed or fully concealed.
    - b. Ceilings eight feet or lower shall be provided with fully concealed sprinkler heads.
    - c. Areas with ceiling height of nine feet or lower, that are not constantly supervised such as corridors, arcades, student restrooms, and other restrooms shall be provided with fully concealed sprinkler heads.
  - 7. Sprinkler heads in light hazard occupancies are required to be Quick Response sprinklers as required in NFPA 13. Sprinkler heads shall be of the same manufacturer throughout the building/site as indicated. Sprinklers shall typically be ½ inches NPT, standard orifice, minimum 5.6 nominal K factor, UL listed for 175 psi, and listed for light and ordinary hazard occupancies.

### **FIRE SUPPRESSION SPRINKLER SYSTEM - 211313**

8. Other specialized sprinkler heads such as walk-in refrigerator or freezer heads, side wall,  $\frac{3}{4}$  inches sprinklers above 5.6 K factor, and those sprinklers with a K factor below 5.6, shall only be used where required by project condition. Large drop sprinkler heads and extended coverage sprinkler heads shall not be installed.
9. Sprinkler head location shall be designed and installed in an aesthetically pleasing manner and should generally be located in the center of 24-inch by 24-inch ceiling tiles and in the center of 24-inch by 48-inch ceiling tiles in the 24-inch direction and no closer than 12-inch from the edge in the 48-inch direction.
10. UL/FM listed Sprinkler head guards shall be provided on Sprinkler heads installed at seven feet six inches above the floor or lower in exposed locations, or that are deemed subject to damage. Sprinkler head guards shall securely fasten with bolt-on feature to the base of the sprinkler or be a factory installed guard. Guards shall also be provided on upright and sidewall heads where sprinklers are installed at seven feet six-inch heights or lower.
11. Sprinkler system piping shall be provided with complete drainage as required by NFPA. Test valve discharge shall be piped away from planters to asphalt areas. Furnish protection of piping against accidental or malicious damage.
12. Upon completion of the Work of this section, and before Substantial Completion, the subject system, including underground supply connection, to tests required. A minimum hydrostatic test shall be two hundred pounds (200 psi) or fifty pounds (50 psi) in excess of the maximum system working pressure, whichever is greater, for two hours with no leaks or loss of pressure per NFPA 13. The Project Inspector shall be furnished with an NFPA 13 test certification.
13. Local fire sprinkler alarm requirements shall be accomplished with a vane or paddle type water flow detector switch and an electrically powered fire sprinkler horn located on the street side of the building and connected to the fire alarm control panel with secondary power provided by the fire alarm batteries. The drilled-out disk shall be attached to the mounting U-bolt. The time delay shall be set at 45 to 60 seconds. Mechanically activated water bells with alarm valves and pressure switches are prohibited.
14. Seismic separation assemblies shall be located between the buildings if space allows accessibility. Otherwise, they shall be located inside the building providing the most space. Swing joints may be fabricated on site using flexible groove couplings and six grooved (Victaulic) 90 degree elbows in a teepee formation (see NFPA 13, figure A.9.3.3). Seismic separation assemblies can also be made utilizing a manufactured, UL/FM listed swing joint assembly rated at a minimum 175 psi.
15. Hanging, bracing and support shall utilize only UL/FM listed approved products, and comply with NFPA 13, Chapter 9 requirements for rod and bolt sizes except for the following: 4 and 6 inch pipe shall be supported by a minimum  $\frac{1}{2}$  inch hanger rod, 8 inch pipe shall be supported by a minimum  $\frac{5}{8}$  inch hanger rod, 10 and 12 inch pipe shall be supported by a minimum  $\frac{3}{4}$  inch hanger rod. Hanger rods in exterior locations and in parking structures shall have Electrodeposited Zinc Coating per ASTM B633 to prevent rusting.

16. Building Fire Sprinkler riser assemblies shall be provided as follows. Every building shall be provided with an accessible and electrically supervised riser shut off valve at a height not to exceed five feet above the floor. Every building riser assembly shall be equipped with a check valve followed by a main drain valve and then the flow indicating switch and pressure gauge immediately after the shut-off valve. In cases where a riser assembly is provided for each floor in the building, a check valve, main drain and flow switch shall be provided for each floor; the main building shut-off shall not be required. An electrically supervised Post Indicator Valve located outside the building may serve as the building riser shut-off valve.

## 2.02 MATERIALS

### A. Automatic Fire Sprinkler Head, UL/FM listed:

AFSH-1	Brass pendant type for areas with suspended ceilings:				
	Victaulic V27	Tyco TY 3231	Viking VK302	Reliable F1FR56	Or equal
AFSH-2	Brass upright type for areas with no ceilings:				
	Victaulic V27	Tyco TY3131	Viking VK300	Reliable F1FR300	Or equal
AFSH-3	Chrome or poly coated semi recessed type with semi-recessed escutcheon:				
	Victaulic	Tyco	Viking	Reliable	Or equal

### B. Escutcheons

ES-1	Chrome plated, or white poly-coated, 2-piece canopy (escutcheon), 2.25 to 3.5 inches in extended position:				
	FPPI 01 - 401 Chrome or White	Tyco No. 401 Chrome or White		Reliable HBC (chrome) HBW (white)	Or Equal
ES-2	Chrome plated or white poly coated, 2-piece recessed:				
	FPPI 01 - 400 01 - 402	Tyco 410 420	Reliable (semi recessed) GF2-C (chrome) GF2-W (white)		Or Equal

### C. Seismic Swing Joints:

SJ-1	UL/FM Approved flexible seismic connector with grooved, or threaded ends for seismic separation requirements.
SJ-2	Fabricated swing joints as per NFPA 13 using six grooves 90 degree elbows and flexible groove couplers such as Victaulic style 75.

### D. Sprinkler Guards:

## FIRE SUPPRESSION SPRINKLER SYSTEM - 211313



- SPG-1 Sprinklers installed at seven feet six inches above floor or lower in exposed locations, or that are deemed subject to damage shall be equipped with a UL/FM listed, head guard. Guards shall be listed, supplied and approved for use with the sprinkler by the sprinkler manufacturer. Sprinkler head guards shall securely fasten with a bolt on feature to the base of the sprinkler or be a factory installed guard. Guards shall also be provided on upright and sidewall heads where sprinklers are installed at seven feet six-inch heights or lower.
- Reliable          Viking          Tyco          FPPI          Victaulic  
Or equal.

E. Hangers, Supports, Bracing:

F. Threaded fittings:

- TF-1 Ductile iron, 300 psi rated, UL listed, FM or NFPA approved.
- TF-2 Cast iron fittings, 175 psi rated, UL listed, FM or NFPA approved:  
Anvil                      Ward                      Taylor Or Equal
- TF-3 Malleable Iron, 300 psi rated, UL, Listed, FM or NFPA approved
- TF-4 Galvanized, 175 psi rated, UL Listed, FM or NFPA approved

G. Fire Sprinkler Pipes:

- FSP-1 Fire sprinkler pipe: 1 inch through 8 inches, Schedule 40, black or galvanized steel meeting ASTM Standards A53, A135, or A795. Pipe Corrosion Resistance Ratio (CRR) shall be 1.00 or greater. The pipe may be threaded or grooved.
- a. Piping 2 inches and smaller shall have threaded joints and fittings in concealed, non-accessible locations. Groove coupler connections (Victaulic, Viking VGS, or equal) on pipe sizes 1 inch through 2 inches are acceptable in accessible areas with required seismic bracing provided. Plain end connections such as "Plainlock" and "FIT" are prohibited.
- b. For pipe sizes 2 ½-inch and larger, grooved type (Victaulic, Viking VGS, or equal), welded, threaded, and flanged connections may be used. Any connection that does not utilize a threaded, welded, or grooved connection is prohibited, except for mechanical tee bolt-on branch outlet fittings sizes 2 inches and smaller (Victaulic 920 and the 920N).

**2.03 ACCESSORIES AND APPURTENANCES**

- A. Escutcheons: Polished chrome plated split-ring type for exposed piping at every penetration inside finished rooms.
- B. Guards: Provide sprinklers with guards at the ceiling at or under seven feet six inches high and where subject to damage or vandalism.
- C. Miscellaneous: Provide accessories and appurtenances for a complete system.

**FIRE SUPPRESSION SPRINKLER SYSTEM - 211313**

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine areas and conditions under which Work in this section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

#### **3.02 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe ends.
- B. Remove scale and foreign matter, from inside and outside of pipes, before assembly.
- C. Provide piping connections to equipment with flanged or grooved connections.

#### **3.03 INSTALLATION**

- A. Pipe through floors, walls, and ceilings, at head locations, shall be furnished with required sleeves, escutcheons, and fire caulking where indicated and/or required by code. Escutcheons shall be polished chrome plated unless another finish is selected by the Architect.
- B. Sprinkler system shall be provided with complete drainage facilities in accordance with CBC standards. Drain discharge may discharge into a sewer, storm drain, sump pit or street gutter. Fire sprinkler drains shall not discharge onto a playground or across a sidewalk. Discharge to plumbing fixtures is prohibited due to the inability of a plumbing fixture to receive a full flow of water from a fire sprinkler drain valve under working pressure.
- C. Upon completion of the Work of this section, and before Substantial Completion, subject the entire system, including underground supply connections, to tests as required by NFPA 13, and CBC standards and furnish the Owner with a certificate of compliance as required.
- D. Close nipples are prohibited. Threaded unions are prohibited. Where a threaded union or coupling is needed, a groove type fitting (Victaulic or equal) shall be used instead. If a groove style coupling is used in a concealed area, an access panel allowing full access to that connection shall be provided.
- E. Fire sprinkler systems piping hangers, seismic bracing, anchors and supports shall conform to NFPA 13, CBC and other applicable codes and the requirements of this specification.
- F. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service and shall be molded and produced by the coupling manufacturer.
- G. Tee branch outlets on fire sprinkler mains shall be by the use of a threaded ductile iron tee fitting, a groove type tee fitting, (Victaulic or equal), or by the use of a thread-a-let welded on by a

#### **FIRE SUPPRESSION SPRINKLER SYSTEM - 211313**

certified welder as required by NFPA. Mechanical tee bolted branch outlet fittings are prohibited except for branch outlet sizes 2 inches and smaller.

- H. Sprinkler lines within the building shall be concealed within the structure. Risers shall be installed in utility, supply rooms, or similar service areas whenever possible, and shall not obstruct access, or maintenance of other equipment within the space. Mains and risers shall be located within the area protected by the sprinkler system unless otherwise approved by fire authorities having jurisdiction.
- I. Sprinklers that have been dropped, damaged, have cracked bulbs, or show a visible loss of fluid shall not be installed.
- J. Sprinkler bulb protectors shall be removed by hand after sprinkler installation. Tools or other devices to remove the protector that could damage the bulb in any way shall not be used.

### **3.04 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

### **3.05 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose at off-project sites.

**END OF SECTION**

## SECTION 22 05 00 - PLUMBING COMMON WORK

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. This Section provides the basic plumbing requirements that apply to the Work of Division 22.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Division 22: Plumbing
  - 3. Division 23: HVAC
  - 4. Division 26: Electrical.

#### 1.02 REGULATORY REQUIREMENTS

- A. Current federal Safe Drinking Water Act (SDWA) regulations require the furnishing of lead-free pipe, solder, and flux in the installation or repair of plumbing in non-residential facilities connected to public drinking water systems. Under this regulation, solders and flux are considered lead-free when they contain 0.2 percent lead or less. Under California regulations pipes and pipe fittings are considered lead-free when they contain 0.25 percent lead or less as defined in California Assembly Bill 1953 (AB 1953). No pipe, pipe fittings, or any other fitting or fixture intended to convey or dispense water for human consumption by drinking or cooking is allowed in the domestic plumbing system, if they do not meet the low lead definition of AB 1953. The weighted average lead content of the wetted surface area of pipes, fittings and fixtures may not exceed 0.25 percent.
  - 1. Provide lead-free water pipe, solder, and flux materials that meet the standards as outlined by the federal SDWA regulations and California AB 1953 if installed in drinking water system.
  - 2. Collect pipe, solder, and flux material samples as required by the Project Inspector. Test samples shall be delivered to an Owner designated testing laboratory for testing of lead content.
    - a. Test samples for lead content by the atomic absorption spectrophotometry method.
  - 3. Materials found not conforming to SDWA and California AB 1953 regulations shall be deemed defective Work and shall be replaced with lead-free materials.
  - 4. Comprehensive testing of the remaining materials for their lead content shall be performed as required by the Project INSPECTOR.
- B. Materials, fabrication, equipment, and installation shall comply with industry standards and code requirements. Where manufacturer's recommendations exceed

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industry standards, the manufacturer's recommendation shall establish the minimum standard. As a minimum, standards from the following organizations shall apply:

1. ANSI - American National Standards Institute.
  2. ASME - American Society of Mechanical Engineers.
    - a. ASME Boiler and Pressure Vessel Code.
    - b. ASME B31 - Standards for Pressure Piping.
  3. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers.
  4. ASTM - American Society for Testing and Materials.
    - a. ASTM A53 Specification for Welded and Seamless Pipe.
  5. AWWA - American Water Works Association.
  6. CSA - Canadian Standards Association.
  7. FM Global - Factory Mutual Global
  8. IAPMO - International Association of Plumbing and Mechanical Officials.
  9. NFPA - National Fire Protection Association.
  10. OSHA - Occupational Safety and Health Administration.
  11. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
  12. UL - Underwriters Laboratories Inc.
  13. Intertek (ETL Certification).
- C. Materials, fabrication, equipment, and installation shall comply with federal, state, and local codes including, but not limited to, the following:
1. CBC, California Building Code, and CMC, California Plumbing Code.
    - a. Latest edition as adopted by the City of Thousand Oaks, the County of Ventura, and the State of California including amendments effective on the Effective Date of the Contract.
  2. California Code of Regulations, Title 8, Industrial Relations, Division 1, Chapter 4, Division of Industrial Safety.
  3. OSHA - Occupational Safety and Health Administration.
  4. CDPH - California Department of Public Health.
  5. SCAQMD – Southern California Air Pollution Control District.
- D. Specifications or Drawings shall not be construed to permit deviation from the requirements of governing codes unless approval has been obtained from legally constituted authorities having jurisdiction, and the Architect. The Contract Documents may contain more stringent requirements than those legally required.
- E. Permits and Fees: Refer to the General and Supplementary Conditions.

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**1.03 SUBMITTALS**

- A. Provide submittals in accordance with Section 01 33 33: Submittal Procedures and with specific requirements of Division 22 sections, as applicable.
- B. The above information shall become the basis for inspecting and testing materials and actual installation procedures performed in the Work.
- C. Shop Drawings: Submit one additional copy when control diagrams having line voltage connections are indicated. Shop Drawings shall be specifically prepared for the Work of this Project. Drawings prepared in accordance with requirements of Section 01 21 00: Project Coordination and Section 01 33 33 may be provided by the Architect to serve as a background for the Shop Drawings. Shop Drawings shall comply with the requirements of Section 01 21 00 and Section 01 33 33 and shall indicate at a minimum:
  - 1. Complete system layout of equipment, components, plumbing fixtures, piping, indicating service clearances, and pipe sizes, fitting types and sizes and pipe elevations, distances of pipes and equipment from building reference points and hanger support locations. The above items shall be coordinated on the shop drawings according to the requirements of Section 01 2100.
  - 2. Schedule and description of equipment, piping and fittings.

**1.04 PROJECT RECORD DOCUMENTS**

- A. Comply with provisions of Section 01 7700: Contract Closeout.
- B. Project Record Drawings:
  - 1. Provide a complete set of plumbing and fire protection drawings in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks and plotter pen color/line thickness settings on CD-ROM. Also submit one set of full-size reproducible plots on vellum and 3 sets of prints.
  - 2. Before Contract Completion, deliver corrected and completed prints to the OAR. Delivery of project record documents to the OAR does not relinquish responsibility of furnishing required information omitted from project record documents.
- C. Operation and Maintenance Manuals:
  - 1. Submit two copies of operation and maintenance manuals in the required form and content. If no revisions are required, furnish one additional copy. If revisions are required, one copy shall be returned with instructions for changes; perform such changes and return three copies of the manuals. Manuals shall be bound in accordance with Section 01 77 00. Deliver manuals to the OAR. Submit an electronic copy of the entire manual in PDF file format.
  - 2. Contents of Manual:
    - a. Title sheet with Project name, including names, addresses and telephone number of Contractor, installer, and related equipment suppliers.

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- b. Manufacturer's operating instructions including, but not limited to, the following:
  - 1) Identification of components and controls.
  - 2) Trouble shooting checklist and guidelines.
  - 3) Recommendations for optimum performance.
  - 4) Warnings and safety precautions on improper or hazardous operational procedures or conditions
- c. Manufacturer's product data and parts and maintenance booklet for each item of equipment furnished under Division 22 that includes the following as a minimum:
  - 1) Manufacturer's model, identification and serial numbers.
  - 2) Exploded view of assembly drawings identifying each component or part with the relevant part number.
  - 3) Directory of manufacturer's representatives, service contractors and part distributors.
  - 4) Maintenance and trouble-shooting instructions, including schedule for preventive maintenance, periodic inspection and cleaning criteria.
- d. Project Record Drawings: Complete set of plumbing, fire protection and control system drawings in 50 percent reduced print format shall be furnished with the manual. Submit the above record drawings on CD-ROM in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks, and plotter pen color/line thickness settings.
- e. Testing, Adjusting, and Balancing reports: Submit as specified in Section 23 05 93.
- f. Santa Monica industrial waste permits.
- h. Valve directory complete with location, function, size, and model of each valve with reference to the project record drawings.
- i. Equipment and component identification chart complete with location, function, size, and model of each equipment or component with reference to the project record drawings.

#### **1.05 COORDINATION**

- A. Contract Documents indicate the extent and general arrangement of Work under Division 22. Contractor shall coordinate work in accordance with Section 01 31 13 requirements and adjust as required to provide maximum headroom, a neat arrangement to keep passageways and openings clear to provide accessibility and provisions for maintenance, and to meet code requirements.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

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- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.
- B. Do not store plastic pipe or materials in direct sunlight.

### **1.07 PRELIMINARY OPERATION**

- A. OAR may require any portion of plumbing Work to be operated before Substantial Completion. Such operation shall be in addition to regular tests, demonstrations and instructions required under the Contract Documents, and shall be performed as required.
- B. Notify the INSPECTOR at least 24 hours in advance of lighting or re-lighting pilots.

### **1.08 TRAINING OF OWNER PERSONNEL**

- A. Training of Owner's personnel shall include:
  - 1. A minimum of 4 hours of on-site overview of the overall Plumbing System.
  - 2. Refer to Division 22 sections for specific training on each of the components of the Plumbing System.
- B. Contract shall include the cost of training Owner operation and maintenance personnel in operating, adjusting, maintenance, troubleshooting, and Project site repair of each component, equipment, or system provided under this Contract.
- C. Operational and maintenance training shall be conducted on the Project site, unless indicated otherwise.
- D. Upon completion of Owner training, a completion certificate indicating the nature of the training and a description of the systems, complete with equipment and component lists shall be issued to each trainee. The certificate should be issued in duplicate with one copy retained by OAR.
- E. An attendance sheet with the names and signatures of all participants attending the training shall be submitted to the OAR and kept as part of the project documents.

### **1.09 GUARANTEES AND DAMAGE RESPONSIBILITY**

- A. Sound of water flowing in piping shall not be transmitted to building structure. The operation of mechanical system shall not produce operational sounds that can be heard outside of rooms enclosing apparatus or equipment.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS AND EQUIPMENT**

- A. Unless otherwise specified, materials and equipment shall be new, in good and clean condition. Equipment, materials, and components shall be of the make; type and model number noted on Drawings or specified. Pieces of equipment of the same type shall be by the same manufacturer.
- B. Whenever an item is listed by a single proprietary name, with or without model number and type, it shall be for purpose of design only, to indicate characteristics and quality desired. Proprietary designation listed on Drawings, or listed first in Specifications, is

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used as a basis for design to establish a standard for quality and performance and space requirements.

- C. Equipment and materials indicated or required to be installed outdoors shall be of the type that is designed, manufactured, listed or approved by authorities having jurisdiction for outdoor installation by being resistant to the adverse effects of weather. The additional protective measures against outdoor weather required by the manufacturers' installation instructions and prevalent practice shall be provided.
- D. For substitution of materials or products, refer to the General Conditions.

### **PART 3 – EXECUTION**

#### **3.01 SERVICE INTERRUPTIONS, OFF-SITE, GAS AND WATER**

- A. Schedule Work so there shall be no service interruptions of existing systems or systems during normal hours of operation of affected systems and facilities.
- B. When service interruptions are mandatory, arrange in advance with the OAR as to the time and date of such interruptions.
- C. Systems which are interrupted, shall be returned to operation in such a manner that they will function as originally intended.

#### **3.02 CUTTING, NOTCHING, AND BACKING**

- A. Conform to California Building Code, Title 24, Part 2, for notches and bored holes in wood and for pipes and sleeves embedded in concrete and for cuts in steel, as detailed on structural Drawings.
- B. Where pipes pass through or are located within one inch of any construction element, install a resilient pad, ½ inch thick minimum, to prevent contact.
- C. Furnish provisions for recesses, chases, and accesses and provide blocking and backing for proper reception and installation of plumbing Work.

#### **3.03 LOCATION OF PIPING AND EQUIPMENT**

- A. Location of piping, apparatus and equipment indicated on the Drawings is approximate and shall be altered to avoid obstructions, preserve headroom, and provide free and clear openings and passageways.
- B. Trenches parallel to footings shall not be closer than 18 inches to the face of footings and shall not be below a plane having a downward slope of 2 horizontal to one vertical, from a line 9 inches above bottom of footing.
- C. Pipe in tunnels shall be installed close to one side of tunnel to provide maximum space for passage. Pipe shall not be installed through crawl hole unless otherwise specified or detailed on Drawings.
- D. Place equipment in locations and spaces indicated, disassemble and/or reassemble equipment as required by Project conditions.

#### **3.04 TESTS AND TESTING**

- A. Tests shall be as required under the applicable sections of Division 22, including this Section.

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- B. Additional tests may be required in the case of products, materials, and equipment if:
1. Submitted items are altered, changed, or cannot be determined as exactly conforming to the Contract Documents.
  2. Performance testing and results may also be required on certain items which are as specified, including fan, and pump performance.

C. Piping Tests:

1. Perform tests required to demonstrate that the operation of plumbing systems and their parts are in accordance with Specifications covering each item or system, and furnish materials, instruments and equipment necessary to conduct such tests. Tests shall be performed in the presence of the Inspector and representatives of any governmental agency having jurisdiction. Work shall not be concealed or covered until required results are provided.
2. If required tests are not performed, Owner may provide in accordance with the Contract Documents.
3. Pressure gauges furnished in testing shall comply with CPC. Air shall be bled from lines requiring hydrostatic or water tests.
4. Systems shall be pressure-tested in accordance with the pipe testing schedule below. Pipe test shall indicate no loss in pressure after a minimum duration of 4 hours at test pressures indicated. Where local codes require higher test pressures than specified herein for fire sprinkler systems, local codes shall govern.
5. Fuel gas lines shall be first tested with piping exposed, before backfilling trenches or lathing; second with piping in finished arrangement, backfilled and paved where required, and walls finished.
6. Piping systems may be tested as a unit or in sections, but the entire system shall successfully meet requirements specified herein, before final testing by the Inspector.
7. Repair of damage to pipes and their appurtenances or to any other structures resulting from or caused by these tests, shall be provided.

D. Pipe Testing Schedule:

<b>System Tested</b>	<b>Test Pressure (psig)</b>	<b>Test With:</b>
Cast-iron soil, waste and interior downspout, condensate drain from air conditioning equipment	10 feet of water, vertically	Water
Domestic water piping, Industrial Hot and Cold Water	200	Water

E. Equipment Performance Assurance Tests:

1. Before operating any equipment or systems, a thorough check shall be performed to determine that systems have been flushed and cleaned as required and that equipment has been properly installed, aligned, lubricated,

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and serviced. Factory instructions shall be checked to verify installations have been completed and recommended lubricants have been installed in bearings, gearboxes, crankcases, and similar equipment. Care shall be furnished in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Equipment shall also be checked for damage that may have occurred during shipment, after delivery, or during installation. Damaged equipment, products, and materials shall be replaced or repaired as required.

2. Upon completion of the above, adjust the system settings to within normal operating conditions to prevent the system from being damaged upon start-up.
3. Run-test the equipment after start-up for five consecutive days. Tests shall include operation of all equipment and systems for a period of not less than two 8-hour periods at 90 percent of the full specified capacities.
4. Equipment Start-up Reports: For each equipment or system on which start-up is performed, submit 8 copies of start-up report for review by the Architect.
  - a. The start-up report shall include the manufacturer's standard start-up form completed and signed by the start-up technician.
5. Provide, maintain, and pay costs for equipment, instruments, and operating personnel as required for specified tests.
6. Provide electric energy and fuel required for tests.
7. Final adjustment to equipment or systems shall meet specified performance requirements.
8. Equipment, systems, or Work deemed defective during testing shall be replaced or corrected as required. Test until satisfactory results are provided.

**F. Specific Coordinated Plan for Test and Balance:**

1. Provide a narrative of the operational intent that clearly describes the function and sequence of operation of each component, equipment, or system installed. Instruct designated Owner personnel in the operation of the installed systems.
2. Prior to final test and balance, plumbing equipment and systems shall be operated and tested as indicated in Article 3.04.F above to demonstrate satisfactory overall operation of the installed systems.
3. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 22 05 13: Plumbing Materials and Methods.

**3.05 NOISE AND VIBRATION REDUCTION**

- A. Correct noise or vibration caused by plumbing systems. Provide all necessary adjustments to specified and installed equipment and accessories to reduce noise to the lowest possible level.
- B. Correct noise or vibration problems caused by failure to install work in accordance with Contract Documents. Include all labor and materials required because of such failure.

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Pay for re-testing of corrected noise or vibration problems by the project acoustical consultant including travel, lodging, test equipment expenses, etc.

**3.06 PROTECTION, CARE AND CLEANING**

- A. In addition to storage criteria of the General Conditions and the following shall be provided:
1. Provide for the safety and good condition of materials and equipment until Substantial Completion. Protect materials and equipment from damage.
  2. Protect installed Work.
  3. Replacements: In case of damage, immediately provide repairs and/or replacements as required.
  4. Protect covering for bearings, open connections to tanks, pumps, compressors and similar equipment.
  5. Interior of piping shall be maintained free of dirt, grit, dust, and other foreign materials.
  6. PVC and CPVC piping shall be protected from sunlight. If outdoors such piping shall covered or painted with a water soluble paint.
  7. Fixtures, piping, finished brass or bronze, and equipment shall have grease, adhesive, labels, and foreign materials removed. Chromium, nickel plate, polished bronze or brass Work shall be polished. Glass shall be cleaned inside and out.
  8. Before initial start-up and again before Substantial Completion, piping shall be drained and flushed to completely remove grease and foreign matter. Pressure regulating assemblies, traps, strainers, boilers, flush valves, and similar items shall be thoroughly cleaned. Tag system with an information tag listing responsible party and date of element before initial start-up and again before Substantial Completion. Compressed air and gas piping shall be blown out with oil-free compressed air or inert gas.

**END OF SECTION**

**SECTION 22 05 13 - PLUMBING MATERIALS AND METHODS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. This Section prescribes basic materials and methods generally common to the Work of Division 22.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Division 22: Plumbing.
  - 3. Division 26: Electrical.

**1.02 SUBMITTALS**

- A. Provide in accordance with Division 01, Section 22 05 00 and specific requirements of each section of Division 22.
- B. Types of welding rods to be used.

**1.03 QUALITY ASSURANCE**

- A. Standards: Comply with applicable national, state, and local codes and standards: ASTM, ASME, and ANSI. Federal Specifications, AWWA, SISPI, NFPA, FM, UL, CPC (California Plumbing Code), CMC (California Plumbing Code), CSA.
- B. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of successful production as reviewed by the Architect.

**1.04 COORDINATION**

- A. Coordinate related Work in accordance with provisions of Division 01

**PART 2 – PRODUCTS**

**2.01 GENERAL**

- A. Provide the following products if they are indicated in the Contract Documents or if they are required for the proper installation, function or operation of equipment, systems or components indicated in the Contract Document.

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- B. Provide the following products as a complete assembly with required accessories for a complete and functioning entity in compliance with governing codes and applicable standards as specified in Section 22 05 00, manufacturer's instructions or as required.
1. Omission of minor details in the Contract Documents does not waive and/or otherwise relinquish compliance with the above requirements.

### 2.02 MANUFACTURERS AND MATERIALS

- A. Ball Valves: Bronze, 2-inch and smaller. Where applicable, compressed air valves shall be cleaned, capped, and bagged to maintain the cleanliness of this system:

BV-1: Class 150, 600 psi, CWP, 2 piece construction reinforced Teflon seats, full port, adjustable packing gland, stainless ball and stem, threaded ends.

Hammond UP-8303A/UP-8305/UP-8513, NIBCO T-685-80-LF/TS-685-66-LF, or Milwaukee UPBA400S/450S.

APPLICATION: Shut-off and isolation of small pipe application for compressed air systems. Recommended for frequent operation readily adaptable to automation, ideal for installation where space is limited. Provide at air compressor discharge line, discharge side of air receiver, compressed air outlets in shop buildings.

NOTE: Valve Handle shall be stainless steel when valve is installed below grade or in the ground valve box.

BV-2: Class 150, 600 psi, CWP two piece construction with reinforced TFE seats, full port, adjustable packing gland, (no threaded stem designs allowed), threaded ends.

NIBCO T-685-80-LF, Hammond UP-8303A, or Milwaukee UPBA-400.

NIBCO T585 S6R66 (Stainless Steel), Milwaukee BA-260 (Stainless Steel).

APPLICATION: BV-1A shall be used on hot domestic and cold water systems.

BV-3 Class 150, 600 psi CWP, 2-piece construction, bronze body, reinforced Teflon seats, adjustable packing gland, (no threaded stem designs allowed), threaded ends.

Hammond UP8301A, NIBCO T-585-70, or Milwaukee BA-400.

APPLICATION: BV-2 to be used only where water is NOT used for water consumption.

Ball Valves in Insulated Piping: Use extended operating handle of non-thermal conductive material, and protective sleeve that allows operation of valve without

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breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied. NIBCO Nib-Seal Handle.

### B. Butterfly Valves:

APPLICATION: Butterfly Valves in a domestic plumbing system intended to convey water for human consumption shall comply with Quality Assurance, article 1.03 of this Section.

BFV-1 Centerline Series A, 200 psi CWP tight shut-off.

1. Body: Lug type ductile iron. Suitable for bi-directional dead-end service at rated pressure without use of downstream flange.
2. Disc: Bronze, or aluminum bronze.
3. Stem: One or two-piece, 400 series stainless steel.
4. Seat and O-Rings: EPDM.
5. Upper and Lower Stem Bearings: Copper alloy or non-metallic material.
6. Operators: Valves 6 inches and smaller, with lever handle. Valves 8 inches and larger, with manual gear operator and disc position indicator.
7. Manufacturers:
  - a) Valves 2.5 to 6-inch: NIBCO, Milwaukee ML-233E, or Hammond 6411-03.
  - b) Valves 8-inch and larger: Milwaukee ML 333E, Hammond 6411-03, or NIBCO LD 2000.

### C. Check Valves:

APPLICATION: Check Valves in a domestic plumbing system intended to convey water for human consumption shall comply with Quality Assurance, article 1.03 of this Section.

1. Bronze, 2-inch and smaller:

CHV-1: 200 psi, CWP horizontal swing, Y pattern, renewable seat and disc, threaded ends.

NIBCO T-413-Y-LF, Milwaukee UP-509, or Hammond UP-904.

Application: Use on domestic hot and cold water systems.

CHV-2: 200 psi, CWP, bronze body, horizontal swing, Y pattern, renewable seat and disc, solder ends.

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Nibco S-413-Y-LF, Milwaukee UP 1509-T, or Hammond Up-946.

APPLICATION: Use on domestic hot and cold water systems.

CHV-3: Special low-pressure check valve for installation in gas lines.

Circle Seal Products Co.

119B-PP-0-15 psi; #1:1/8 inch IPS; #2:1/4 inch IPS #3:3/8 inch IPS.

APPLICATION: For low pressure gas in chemistry laboratory systems.

**D. Gate Valves:**

APPLICATION: Gate valves in a domestic plumbing system intended to convey water for human consumption shall comply with Quality Assurance, article 1.03.

**1. Bronze, 2-inch and smaller:**

GV-1 Class 125, 200 psi CWP, bronze body and bonnet non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Hammond IB645, Crane 1701, Milwaukee 105, or American 3F, NIBCO T-113.

APPLICATION: Shut-off and isolation of equipment and device for gas system.

GV-2 Class 125, 200 psi, CWP, bronze body and bonnet, non-rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

NIBCO T-113-LF, Milwaukee UP 105, or Hammond UP 645.

APPLICATION: Use on domestic hot and cold water systems.

GV-3 Same as GV-1, except solder ends:

NIBCO S 113, Milwaukee 115, or Hammond IB 647.

APPLICATION: Same as GV-1. Provide in yard box, to each group of fixtures behind access panels, where valves are located near ceiling and beams.

GV-4 Class 125, 200 psi WOG, rising stem, inside screw, screw-in bonnet, solid disc, threaded ends:

Stockham B-100, Crane 428, NIBCO T-111, Milwaukee 148, or Hammond IB-640.

APPLICATION: Same as GV-3 except where clearance is not an issue. Adequate clearance for operation must be provided because hand wheel and stem rise. Provide inlet and outlet connections to water heaters and pumps, make up water lines to HVAC equipment and expansion tanks.

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GV-5 Class 250, 250 psi, CWP, O S and Y, IBBM, resilient seat gate valve, flanged ends.

Watts 408-OSY-RW or Kennedy 7168.

The epoxy coated valves are recommended in the domestic cold water system where corrosives in the water line might cause damage to the inside of valve and where pressure rating more than 200 psi is required.

GV-6 Class 125 250 psi CWP iron body, flanged ends, bolted bonnet with wheel handle, resilient wedge, non-rising stem.

APPLICATION: For use in walls for cold water system pipe sizes 2 ½-inch and larger.
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NIBCO F-619-RW.

- E. Pipe and Fitting Requirements Schedule: Unless otherwise specified or indicated on Drawings, pipe and fittings shall be installed in accordance with the following table:

TABLE I  
PIPE AND FITTING SCHEDULE

Use	Limits	Pipe	Fittings
Sanitary Waste and Vent, Storm Drain Systems Above Grade	Above Grade	P-1	PF-1
Sanitary Waste and Vent, Storm Drain Systems Below Grade	Below Grade	P-2	PF-2
Copper Drainage Tube (Above Ground)	Waste and Vent	P-3	PF-3
Acid Waste and Vent	All	P-4	PF-4
	Rated Wall Penetrations only	P-5	PF-5
Domestic Hot and Cold Water	Above Grade	P-6	PF-6
Domestic Hot and Cold Water	Below Grade	P-9	PF-9
Industrial Hot and Cold Water	Above Grade	P-6	PF-6
Industrial Hot and Cold Water	Below Grade	P-9	PF-9
Condensate drains and drains From HVAC Equip.	Above Grade	P-6	PF-6
Gas Natural	Underground	P-7	PF-7
Gas Natural	Above ground	P-8	PF-8
Deionized Water	All	P-10	PR-10

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F. Piping:

APPLICATION: PIPES IN A DOMESTIC PLUMBING SYSTEM INTENDED TO CONVEY WATER FOR HUMAN CONSUMPTION SHALL COMPLY WITH QUALITY ASSURANCE ARTICLE 1.03.

1. Piping shall be continuously and permanently marked with manufacturer's name, type of material, size, pressure rating, and the applicable ASTM, ANSI, UL, or NSF listing. On plastic pipe, date of extrusion must also be marked.
2. Underground non-ferrous pressure pipes shall be installed with proper color tracer wires. Refer to color code provisions in Section 22 0553: Plumbing Identification.
- P-1 Cast iron: Hubless, service weight, ASTM A888, CISPI 301, conforming to CISPI 310 and installed in accordance with IAPMO 1S 06 by American Foundry, Tyler, or AB & I.
- P-2 Cast iron: Hubless, service weight, ASTM A888, CISPI 301, conforming to CISPI 310 and installed in accordance with IAPMO 1S 06 by American Foundry, Tyler, or AB & I. and wrapped in 5 mil plastic.
- P-3 Copper drainage tube, inside structure and above grade. Type DWV hard temper, ASTM B 306 by Mueller, Anaconda, Cerro Brass, Cambridge-Lee, or Halstead.
- P-4 CPVC-CW Schedule 40 Pipe Special drainage systems for corrosive chemical or acid waste shall be manufactured from CPVC Type IV, ASTM Cell Classification 23447 from Spears® Manufacturing Company. All pipe shall be Schedule 40 CPVC manufactured to dimensional requirements of ASTM F441. All pipe markings shall be accompanied by a yellow stripe for identification of CPVC chemical waste system. CPVC system shall be available in sizes 1-1/2 through 24-inch iron pipe size (IPS) dimensions. Joining method for pipe and fittings shall be solvent cement welding. Solvent cement shall be a "one-step" primerless type CPVC cement designated by the system manufacturer, specially formulated for resistance to corrosive chemicals and manufactured in accordance with ASTM F493. Mechanical connections for special equipment connection or transition to other system materials shall be as specified by the CPVC system manufacturer.. All pipe shall be CAN/ULC S102.2 Listed for flame spread and smoke development with rating designated on the pipe marking. All pipe, fittings, and cement shall be supplied together as a complete system certified by the NSF international for use in corrosive waste drainage systems as a Special Engineered (SE) Product. Installation shall be in accordance with the manufacturer's instructions and all applicable codes. Special drainage system to be Spears® LabWaste™ CPVC Corrosive Waste Drainage Systems manufactured by Spears® Manufacturing CompanyE. Before

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installing LabWaste™ piping workers shall receive factory training and provide evidence of their training.

- P-5 Type 316L Stainless steel chemical waste pipe, marked with manufacturer's identification. Piping system shall be provided with a five-year manufacturer's material warranty by Blucher-Josam.
- P-6 Copper water tube, Type L hard, ASTM B88 by Mueller, Cambridge-Lee, Halstead. Compressed air piping should be cleaned and capped copper as noted on Plumbing drawings. Medical/Oxygen grade.
- P-7 Polyethylene plastic pipe, ASTM D 2513, standard dimension ratio. 11, rated at 80 psi working pressure at 73 degrees Fahrenheit (F). for 3-inch and smaller, SDR 11.5 rated at 76 psi at 73 degrees F. for 4-inch and above, butt or socket type fittings, joined by heat fusion, orange or yellow color. Transition to anodeless steel riser at meter, regulator, or building wall by CPCHEM (Chevron Phillips Chemical Company LP) PE 2406
- P-8 Black steel pipe Schedule 40, ASTM A53, Type E, ERW by US Steel.
- P-9 PVC, thick wall, cast-iron OD sized, UL listed, AWWA listed, NSF listed, Class 200 with tracer wire by Blue Brute.
- P-10 High Purity Low Extractable Schedule 80 PVC by Spears "LE" UPW process piping and fittings shall be manufactured from a specialty low-extractable, Polyvinyl Chloride (PVC) compound with a Cell Classification of 12343 per ASTM D1784. All pipe and fittings shall be produced to Schedule 80 dimensions, manufactured in strict compliance with ASTM D1785 (pipe), and ASTM D2467 (fittings). These products shall carry a Type II pressure rating and consistently meet or exceed the applicable Quality Assurance test requirements of these standards about dimensions, workmanship, burst pressure, flattening resistance and end-product quality. All UPW process valves shall be True Union-style diaphragm or True Union-style quarter-turn ball valves produced from the same low-extractable PVC compound. All valve diaphragms and seats shall be PTFE; valve O-rings shall be EPDM or FKM as applicable. All valve union nuts shall have buttress-style threads. All valve components shall be replaceable. System components shall be joined utilizing Spears® One-Step specialty solvent cement specifically formulated for joining the system that meet or exceed the requirements of ASTM D2564. All system components shall be manufactured in the USA by an ISO-certified manufacturer. All UPW piping and fittings shall be bagged and sealed immediately after manufacture to maintain cleanliness and boxed and stored indoors at the manufacturing facility until shipped from the factory. UPW process pipe, fittings, valves and cement shall be manufactured by Spears® Manufacturing Company. Before installing LE piping workers shall receive factory training and provide evidence of the training.

### G. Pipe Fittings:

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**APPLICATION:** Pipe fittings in a domestic plumbing system intended to convey water for human consumption shall comply with Quality Assurance, article 1.03.C.

- PF-1 Cast iron, soil or waste no-hub coupling with neoprene gaskets, stainless steel corrugated shields and stainless steel clamps. 2 bands, IAPMO, ASTM C 564 and CISPI 310 by American Foundry, or Mission, Tyler.
  
- PF-2 Cast iron, soil or waste, Heavy-duty no-hub coupling with neoprene gaskets, stainless steel corrugated shields and stainless steel clamps. 4 bands. 5 mil wrapped IAPMO, ASTM C564 and CISPI 310 by American Foundry, Mission, or Tyler.
  
- PF-3 Cast brass drainage fittings ASA B 16.23, ASTM B 42. Provide with copper drainage tube by Mueller Brass, Nibco, Stanley Flagg, or Lee Brass.
  
- PF-4 CPVC-CW. All fittings shall be CPVC drainage patterns meeting the requirements of ASTM D3311 and specialty patterns according to the manufacturer's specifications. CPVC system shall be available in sizes 1-1/2 through 24-inch iron pipe size (IPS) dimensions. Joining method for pipe and fittings shall be solvent cement welding. Solvent cement shall be a "one-step" primerless type CPVC cement designated by the system manufacturer, specially formulated for resistance to corrosive chemicals and manufactured in accordance with ASTM F493. Mechanical connections for special equipment connection or transition to other system materials shall be as specified by the CPVC system manufacturer. All molded fittings shall be CAN/ULC S102.2 Listed for flame spread and smoke development and rating designated on the original package labeling. All pipe, fittings, and cement shall be supplied together as a complete system certified by the NSF international for use in corrosive waste drainage systems as a Special Engineered (SE) Product. Installation shall be in accordance with the manufacturer's instructions and all applicable codes. Special drainage system to be Spears® LabWaste™ CPVC Corrosive Waste Drainage Systems manufactured by Spears® Manufacturing Company. The system shall be protected from fire stopping materials, thread sealant, plasticized vinyl products or other aggressive chemical agents not compatible with CPVC compounds.
  
- PF-5 Type 316L Stainless steel chemical waste pipe, marked with manufacturer's identification and fittings. Mechanical press fit joints with EPDM seals Manufacturer's representative shall instruct installers and certify them for joint installation by Blucher-Josam.
  
- PF-5 ProPress Fittings by Viega: Copper shall conform to ASME B16.51, ICC LC 1002, IAPMO PS 117, NSF 61, and NSF 61-G or NSF 372. ProPress fittings ½-inch thru 4-inch for use with ASTM B88 copper tube type K, L, or M and ½-inch up to include 1-1/4-inch annealed copper tube. ProPress fittings shall have an EPDM sealing element and Smart Connect (SC) feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element and Smart Connect (SC) feature.

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- PF-6 ProPress Fittings by Viega: Copper shall conform to ASME B16.51, ICC LC 1002, IAPMO PS 117, NSF 61, and NSF 61-G or NSF 372. ProPress fittings ½-inch thru 4-inch for use with ASTM B88 copper tube type K, L, or M and ½-inch up to include 1-1/4-inch annealed copper tube. ProPress fittings shall have an EPDM sealing element and Smart Connect (SC) feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element and Smart Connect (SC) feature. All fittings to be wrapped. Compressed air piping should be cleaned and capped copper as noted on Plumbing drawings. Medical/Oxygen grade.
- PF-7 Polyethylene plastic fittings, ASTM D 3261 and D 2683, standard dimension ratio 11, rated at 80 psi working pressure at 73 degrees F. for 3 inches and smaller, SDR 11.5 rated at 76 psi at 73 degrees F. for 4 inches and above, butt or socket type fittings, joined by heat fusion, color orange or yellow by CPCHEM, (Chevron Phillips Chemical Company LP).

Polyethylene transition risers, for PF-7 above, Transition fitting must have a minimum vertical height of 36 inches from the horizontal connection which will allow for a 6-inch steel riser above ground. Polyethylene transition risers shall be anodeless by Central Plastics Company.

Application: installed in a gas piping system for the purpose of providing a transition from horizontal below ground (polyethylene) to vertical above ground (steel). Transition must be made on the horizontal side of the gas piping system and meet ASTM standards for Polyethylene plastic pipe and fittings.

- PF-8 Viega, MegaPress G Fittings: ½-inch through 2-inch shall conform to ANSI LC4-2012 /CSA 6.32-2012 2nd Edition. MegaPress G fittings with zinc/nickel coating for use with IPS schedule 10 through schedule 40 carbon steel, or galvanized pipe conforming to ASTM A53. MegaPress G fittings shall have an HNBR sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Smart Connect (SC) Feature.
- PF-9 Cast-iron OD sized, bell and spigot gasket joints.
- PF-10 High Purity Low Extractable Schedule 80 PVC by Spears "LE" UPW process piping and fittings shall be manufactured from a specialty low-extractable, Polyvinyl Chloride (PVC) compound with a Cell Classification of 12343 per ASTM D1784. All pipe and fittings shall be produced to Schedule 80 dimensions, manufactured in strict compliance with ASTM D1785 (pipe), and ASTM D2467 (fittings). These products shall carry a Type II pressure rating and consistently meet or exceed the applicable Quality Assurance test requirements of these standards about dimensions, workmanship, burst pressure, flattening resistance and end-product quality. All UPW process valves shall be True Union-style diaphragm or True Union-style quarter-turn ball valves produced from the same low-extractable PVC compound. All valve diaphragms and seats shall be PTFE; valve O-rings shall be EPDM or FKM as applicable. All valve union nuts shall have buttress-style threads. All valve components shall be replaceable. System components shall be joined

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utilizing Spears® One-Step specialty solvent cement specifically formulated for joining the system that meet or exceed the requirements of ASTM D2564. All system components shall be manufactured in the USA by an ISO-certified manufacturer. All UPW piping and fittings shall be bagged and sealed immediately after manufacture to maintain cleanliness and boxed and stored indoors at the manufacturing facility until shipped from the factory. UPW process pipe, fittings, valves and cement shall be manufactured by Spears® Manufacturing Company.

### H. Pipe Isolators:

PLA-1 Absorption pad shall be not less than ½ inch thick, unloaded. Pad shall completely encompass pipe.

APPLICATION: For copper piping.

Holdrite, LSP, Stoneman, Potter-Roemer, Trisolator, or PR-Isolator.

### I. Pressure Gage: Aluminum or steel case, minimum 4 ¼-inch dial; pressure type or combination vacuum-pressure type, with provisions for field calibration. Dial indicator to indicate pressure in psi with accuracy to within plus or minus 0.5 percent of maximum dial reading. Furnish gages with restriction screw, size 60, to eliminate vibration impulses. Black case and ring, bourdon tube of seamless copper alloy with brass tip and socket. Three way gage cock, constructed of brass with stuffing box, 1/2 inch couplings, with fixed or movable cap nut to shut off pressure gage.

PG-1 Pressure type, black drawn steel case, 4-1/2-inch glass dial, range approximately twice line pressure.

Marsh Keckley, Terice, Weksler, or Weiss.

### J. Plug Valves:

PV-1 2 inches and smaller: Rockwell No.114, lubricated plug type, 200-pound., water operating gauge pressure iron body and plug, regular pattern, threaded, with indicating arc; by Walworth, Homestead, WKM.

APPLICATION: Isolation and on-off application for gas system.

PV-2. 2 ½-inch and larger: Rockwell No.115 and No.165 lubricated plug type, 200 pound water operating gauge. Iron body and plug, regular pattern, flanged, with indicating arc. Walworth, Homestead, WKM.

APPLICATION: Same as PV-1.

### K. Strainers:

STR-1 Description: Wye type with monel or stainless steel strainer cylinder (manufacturer's standard mesh), and gasketed machine strainer cap. Where indicated on Drawings, provide with valved (globe valve) blowout piping, same size as blowout plug.

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1. 2-inch and smaller:

C.M. Bailey No.100-A, 250 lb., cast iron body, threaded, Keckley 'B', or Spirax Sarco Y-type.

2. 2 ½-inch and larger:

C.M. Bailey No.100-A, 125 lb., cast iron body, flanged, or Victaulic style 732, 300 psi, ductile iron body, grooved, fusion bonded epoxy coated.

C.M.Bailey, Armstrong, Muessco, or Keckley 'A'.

APPLICATION: Gas systems.

- STR-2 Flanged, bucket type, semi-steel body, 125 psi, stainless steel screen with 1/8 inch diameter perforations, all sizes.

Bailey No.1, Zurn 150 Series, RP&C, or Keckley GFV.

APPLICATION: Domestic cold and hot water system. Mount above grade for water service).

- L. Flanges: Flanges shall be furnished and installed at each flanged connection of each type of equipment, tanks, and valves. Faces of flanges being connected shall be furnished alike. Connection of a raised face flange to a flat-faced flange is not permitted. Flanges shall conform to following schedules:

TYPE OF PIPE	FLANGE
Screwed black or galvanized grooved steel pipelines.	125 pound black cast iron screwed flange, flat faced or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, or Gruvlok Fig. 7401.
Welded or grooved steel pipe	150 pound black forged steel welding flanges, 1/16 inch raised face ASTM A 105, Grade II or grooved flange adapters, Victaulic Style 741, Tyco-Grinnell Fig. 71, or Gruvlok Fig. 7401.
Copper and brass pipe or tubing.	150 pound cast bronze, flat-faced flange with solder end or grooved flange adapters, Victaulic Style 641, Tyco-Grinnell Fig. 61, or Gruvlok Fig. 6084.

1. Gasket material for flanged connections shall be full faced or ring type to suit facing on flanges and shall be furnished in accordance with following schedule:

SERVICE	TYPE
Cold water	1/16 inch thick neoprene

Grooved end flange adapters supplied with pressure responsive elastomeric Gaskets supplied with grooved flange adapters shall be pre-lubricated by the manufacturer. Grade of gasket to suit intended service.

- M. Unions:

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1. Unions shall be furnished and installed in accordance with the following requirements (unless flanges are furnished):
  - a. At each threaded or soldered connection to equipment and tanks, except in Freon or fuel gas, piping systems, whether indicated or not.
  - b. Immediately downstream of any threaded connection to each manually operated threaded valve or cock, and each threaded check valve, yard box or access box except those in Freon piping systems, whether indicated or not.
  - c. At each threaded connection to threaded automatic valves (except those in Freon piping systems) such as reducing valves and temperature control valves, whether indicated or not.
  - d. If grooved piping is used, couplings shall serve as unions. Additional unions are not required
2. Unions shall be located so that piping can be easily disconnected for removal of equipment, tank, or valve.

### PART 3 – EXECUTION

#### 3.01 EXAMINATION

- A. Examine areas and conditions under which Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

- A. Provide all materials and equipment for the Work. Furnish and install necessary apparatus, parts, materials, and accessories.
- B. Pipe Installation:
  1. Install piping parallel to the wall and provide an orderly grouping of proper materials and execution.
  2. Piping shall clear obstructions, preserve headroom, provide openings and passageways clear, whether indicated or not. Verify the Work of other Divisions to avoid interference.
  3. If obstructions or the Work of other Divisions prevent installation of piping or equipment as indicated by the Drawings, perform minor deviations as required by the Architect.
  4. Install piping after excavation or cutting has been performed. Piping shall not be permanently enclosed, furred in, or covered before required inspection and testing is performed.

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5. Exposed polished or enameled connections from fixtures or equipment shall be installed with no resulting tool marks or threads at fittings. Residue or exposed pipe compound shall be removed from exterior of pipe.
6. Piping shall be concealed in chases, partitions, walls, and between floors, unless otherwise directed or specifically noted on Drawings. When penetrating wood studs, joists, and other wood members, provide such members with reinforcement steel straps of Continental Steel & Tube Co., ULINE, Independent or Metal Strap.
7. Reduce fitting where any change in pipe size occurs. Bushings shall not be furnished unless specifically reviewed by the Architect or indicated on Drawings.
8. Piping subject to expansion or contraction shall be anchored in a manner which permits strains to be evenly distributed. Swing joints or expansion loops shall be installed. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping. Seismic loops are required at all building separations.
9. Immediately after lines have been installed, openings shall be capped or plugged to prevent entrance of foreign materials. Caps shall be left in place until removal is necessary for completion of installation.
10. Couplings shall not be installed except where required pipe runs between other fittings are longer than the standard length of type of pipe being installed and except where their installation is specifically reviewed by the Architect.
11. Water piping shall be installed generally level, free of traps, unnecessary offset, arranged to conform to building requirements, clear of ducts, flues, conduits, and other Work. Piping shall be arranged with valves installed to provide for complete drainage and control of the system. Piping shall not be installed which causes an objectionable noise from the flow of water therein under normal conditions. Refer to Section 23 0500: Common Work Results for Plumbing.
12. Water lines may be installed in the same trench with sewer lines, provided bottom of water line is 12 inches minimum above top and to the side of sewer line.
13. Changes in pipe sizes shall be furnished with eccentric reducers, flat on top. Offsets to clear obstruction shall not be installed to produce air pockets.

### C. Pipe Sleeves and Plates:

1. Provide pipe sleeves of Schedule 40 black steel pipe or Schedule 40 PVC plastic pipe in concrete or masonry walls, footings, and concrete floors below grade. Provide adjustable submerged deck type sleeves at locations where pipes pass through concrete floors, except concrete slab floors on grade, and at locations where soil pipe for floor type water closets passes through concrete floors.

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<p><u>Application:</u> FOR FIRE RATED WALL PENETRATIONS FOLLOW THE UNIFORM BUILDING CODE.</p>
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2. Sleeves shall provide ½ inch clearance around pipes, except plastic pipe shall have 1 inch clearance. Caps of deck type sleeves shall be removed just prior to installation of pipe. Area around sleeves shall be smooth and without high or low spots. Sleeves in walls shall not extend beyond exposed surface of wall. Sleeves in concrete floors and walls shall be securely fastened to forms to prevent movement while concrete is being placed.
  3. Piping installed on a roof shall clear the roof surface by 10 inches minimum, with or without insulation. Bottom of individual fittings may infringe on 10 inches clear space but not groups of fittings or fittings located within 27 inches of each other.
  4. Stiles shall be provided to facilitate crossing of piping when parallel piping runs are laterally greater than 12 inches out-to-out, or any pipe is higher than 18 inches, and more than 40 feet long or runs between two or more major pieces of equipment or housings greater than 20 feet apart. Stiles shall be not less than 20 inches wide with a minimum tread depth of 10 inches. Where stiles are required, they shall be located so the greatest obstructed distance is 30 feet.
  5. Where pipes pass through waterproofed walls, floors, or floors on grade, sealant with Link-Seal Modular Seals, between pipe and sleeve to provide a waterproof joint. Where earth is in contact with pipe on both sides of a wall or foundation, the waterproof joint is not required. Commercial rubber compression units may be furnished instead of sealed sleeves if reviewed by the Architect.
  6. A swing joint, or other required device, shall be furnished and installed in hot water lines with 10 feet of sealant or compression joint to allow for expansion.
  7. Provide polished, chrome-plated flanges when plumbing pipes pass through walls at plumbing fixtures, etcetera as specified in Section 22 4000 Plumbing. Provide polished steel, chromium-plated split floor and ceiling plates at locations where pipes pass through walls, floors, ceilings, and partitions in finished portion that neatly conceals pipe insert.
  8. Pipe sleeves shall be provided where pipes intersect footings or foundation walls and sleeve clearances shall provide for footing settlement, but not less than one inch all around pipe.
- D. Pipe Joints and Connections:
1. Pipe and tubing shall be cut per IAPMO Installation Standards. Pipe shall have rough edges or burrs removed so that a smooth and unobstructed flow shall be provided.
  2. Hot tapping of gas lines is strictly prohibited.

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3. Threaded Pipe: Joints in piping shall be installed according to the following service schedule:
    - a. Cleanout Plugs: No compound shall be used. After inspection and test, plugs shall be removed, cleaned, greased, and replaced.
  4. Threads on pipe shall be cut with sharp, clean, unblemished dies and shall conform to ANSI/ASME B2.1 for tapered pipe threads.
  5. Joint compounds shall be smoothly placed on male thread and not in fittings. Threaded joints shall be installed tight with tongs or wrenches and sealant of any kind is not permitted. Failed joints shall be replaced with new materials. Installation of thread cement or sealant to repair a leaking joint is not permitted.
  6. Sharp-toothed Stillson, or similar wrenches, is not permitted for the installation of brass pipe or other piping with similar finished surfaces.
- E. Copper Tubing Fittings:
1. Viega, ProPress copper fittings: Tube ends shall be cut on a right angle (square) to the tube. Tube ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting. Utilizing a Viega Insertion Depth Inspection Gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the tube fully into the fitting and mark the tube wall at the face of the fitting. Always examine the tube to ensure it is fully inserted into the fitting prior to pressing the joint. ProPress fittings ½-inch thru 4-inch shall be joined using appropriately sized Ridgid ProPress Tools. ProPress fittings shall be installed according to the most current edition of the Viega installation guidelines. Installers shall attend a Viega ProPress installation training class.
  2. After ProPress fittings have been installed a “two step test” shall be followed. Pressurize the system with the application of an appropriate test medium, water between 15 and 85 psi, or air/dry nitrogen between .5 and 45 psi. Check the pressure gauge for pressure loss. If the system does not hold pressure, walk the system and check for un-pressed fittings. Should you identify an un-pressed fitting/s ensure the tube is fully inserted into the fitting, and properly marked, prior to pressing the joint. After appropriate repairs have been made, retest the system per local code, or specification requirements, not to exceed 600 psi with water or 200 psi when using air.
- F. Gas Pipe Joints:
1. Viega, Mega Press G Systems: Sealing elements shall be verified for the intended use. Pipe ends shall be cut on a right angle (square) to the pipe. Pipe ends shall be reamed chamfered, and all paint, lacquer, grease, oil or dirt shall be removed from the pipe end with an abrasive cloth, or with the Ridgid MegaPress pipe end prep tool. Visually examine the fitting sealing element to ensure there is no damage. Utilizing a Viega MegaPress

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Insertion Depth Inspection Gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting. Always examine the pipe to ensure it is fully inserted into the fitting prior to pressing the joint. MegaPress G fittings shall be installed using Ridgid, MegaPress Tools. MegaPress G fittings shall be installed according to the most current edition of the Viega installation guidelines. Installers shall attend a Viega MegaPress installation training class.

2. Test: After MegaPress G fittings have been installed a "two step test" shall be followed. Utilizing air, or dry nitrogen, pressurize the system between .5 psi and 45 psi. Check the pressure gauge for pressure loss. If the system does not hold pressure, walk the system and check for un-pressed fittings. Should you identify an un-pressed fitting/s ensure the pipe is fully inserted into the fitting and properly marked prior to pressing the joint. After appropriate repairs have been made, test the system per local code, or specification requirements, not to exceed 200 psig.

**G. LE Pipe**

1. Spears® Low Extractable PVC is joined using a One-step solvent cement system specially formulated for high purity applications. Install per manufacturer's requirements.

**H. Polyethylene (Plastic) Pipe:**

1. Joints shall be installed by the heat fusion method, in accordance with manufacturer's recommendations and IAPMO installation standard IS 12, for natural gas.
2. Pipe Riser at Meter, Regulator and Building Wall: Prefabricated, anodeless type, utilizing a grade level transition between underground polyethylene pipe and gas supply steel pipe of riser outlet, R. W. Lyall Co.,. Below grade to above grade transition shall be installed in a welded, epoxy coated, steel casing.
3. Connections to Existing Pipeline or Branch:
  - a. Steel-to-plastic (PE): Provide manufacturer's prefabricated standard transition fitting, transition from epoxy-coated steel pipe to plastic, R. W. Lyall Co.
  - b. Plastic-to-plastic, PVC to PE: Provide manufacturer's prefabricated standard transition fitting, transition from PVC to epoxy-coated steel pipe to PE; R.W. Lyall Co.
  - c. Plastic-to-plastic, PE to PE: Provide manufacturer's standard fused tapping tee assembly with shut-off feature.
4. Provide PE reinforcing sleeves where PE pipe is fused to multi-saddles, service punch tee, reducing tees, transition fittings and anodeless risers.

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- I. Valves: Valves shall conform to the following:
  1. Piping systems shall be furnished with valves at points indicated on Drawings and specified, arranged to provide complete regulating control of piping system throughout building and the Project site.
  2. Valves shall be installed in a neat grouping, so that parts are easily accessible and maintained.
  3. Valves shall be full size of line in which they are installed, unless otherwise indicated on Drawings or otherwise specified, and shall be one of types specified.
  4. Provide chain operators on valves 2-inch and larger located 7 feet or more above the servicing floor level.
  5. Valves for similar service shall be of one manufacturer.
  6. Except where otherwise specified, valves shall be Belimo, Victaulic, Stockham, Crane, Jenkins, Milwaukee, Hammond, American, NIBCO, or Hoffman.
  7. Ball valves below grade in yard boxes shall have stainless steel handles.
  8. Hose bibs in dense garden areas shall be  $\frac{3}{4}$  inch in size with one hose bib in the lunch pavilion 1 inch in size. Other hose bibs shall be  $\frac{3}{4}$  inch lock shield type. Bibs shall be furnished with vacuum breaker protection.
  9. Safety valves and pressure relief valves shall have stamp of approval as required by ASME and shall be provided with an annual test lever. Where a hot water storage tank is heated by means of a coil, pressure relief valve shall have a steam BTU discharge rating of the coil. Discharge pipe from safety or pressure relief valves shall be not less than one pipe size larger than inlet pipe size of valve. Discharge pipe shall terminate as indicated and shall be free of traps. In addition to locations specified, pressure relief valves shall be installed in the following locations:
    - a. On discharge side of each pressure-reducing valve.
    - b. On each water heater connected to a hot water storage tank and other pressure vessels.
    - c. On cold water line to each water heater or hot water storage tank when there is a check valve, backflow prevention valve or similar device between water heater or hot water storage tank and meter or relief valve at the pressure reducing valve assembly.
    - d. On discharge side of each air compressor.
    - e. On each air receiver connected to an air compressor.

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10. Temperature relief valves and combination temperature and pressure relief valves shall be as specified and furnished as set forth in this Section. Discharge pipe from relief valves shall be not less than discharge area of valve or valves it connects, based on discharge area of valves, and shall terminate as indicated and free of any traps. Valves shall be installed at following locations:
  11. A combination temperature and pressure relief valve or combination of valves on each heating hot water storage tank. Temperature sending element shall extend into water inside tank.
  12. Manual air vent valve assemblies shall be installed at each high point of hot water space heating and chilled water piping systems. Valves shall discharge through 1/4 inch diameter copper tubing and drain to nearest floor sink. Automatic type air vent valve shall only be installed where specifically indicated. Radiator, convectors, and finned pipe convectors shall be fitted with packless radiator valves, angle or straight pattern. Each convector or radiator installed as part of a space hot water heating system shall be furnished with a manual-type air vent valve.
- J. Strainers: Strainers shall be installed on each water main (except for fire line) downstream of the meter, above grade, when a pressure regulator assembly is not installed. Main strainer shall be of Y-flange or groove type. On closed loop chilled and heating hot water systems pump systems, a strainer shall be installed at each pump inlet and upstream of each flow control valve assembly. The control valve assembly may include a modulating temperature control valve and a flow-limiting valve, manufactured by Griswold, AutoFlow, or Flow Control Industries, Inc..
- K. Hangers and Supports:
1. Piping shall be securely fastened to building structure by approved iron hangers, supports, guides, anchors, and sway braces to maintain pipe alignment to prevent sagging and to prevent noise or excessive strain on piping due to uncontrolled or seismic movement under operating conditions. Hangers and supports shall conform to Manufacturer's Standardization Society Specification SP-69. Hangers shall be relocated as required to correct unsatisfactory conditions that may become evident when the system is placed into operation. Appliances, heat exchangers, storage tanks, and similar equipment shall be securely fastened to structure in accordance with seismic requirements. Outdoor metal hangers and supports shall be hot-dipped galvanized steel, unless otherwise specified.
  2. Hose faucets, compressed air outlets, and similar items at ends of pipe branches shall be rigidly fastened to building construction near point of connection.
  3. Piping shall not be supported by wire, rope, wood, plumbers' tape, or other non-recognized devices.
  4. Hangers and supports shall be designed to support weight of pipe, fittings, weight of fluid and weight of pipe insulation, and shall have a minimum

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- factor of safety of five, based on ultimate tensile strength of material installed.
5. Burning or welding of any structural member under load is not permitted. Field welding not specified on Drawings or reviewed Shop Drawings is not permitted without review by Architect.
  6. Burning holes in beam flanges or other structural members is not permitted without review by the Architect.
  7. Pipe hangers on piping covered with low temperature insulation shall be installed on the outside of insulation and not in contact with pipe unless otherwise detailed on Drawings. Insulation shall be protected by 18 gage galvanized steel shield, with a minimum length of 10 inches, installed completely around pipe covering between covering and hanger. Installing hangers directly on pipe and butting adjoining sections of insulation against hanger is permitted provided void and hanger rod are properly insulated and sealed so that no sweating occurs at hangers.
  8. Hanger rods shall be fastened to structural steel members with suitable beam clamps. Clamps shall be Tolco, Carpenter & Patterson, Fee and or Mason, as follows:
    - a. Tolco I beam, Fig.62 for maximum 1000 pounds.
    - b. Tolco I or WF beam, Fig. 329, for a maximum of 1290 pounds.
  9. Hanger rods shall be fastened to concrete inserts in concrete slabs or beams. Inserts shall be Tolco, Carpenter & Patterson, Fee and or Mason, as follows:
    - a. Tolco Fig.310 for maximum of 600 pounds.
    - b. Tolco Fig. 309 for maximum of 1140 pounds.
  10. For fastening to wood ceilings, beams, or joists, furnish Grinnell Fig. 128R, Grinnell Fig. 153, Tolco 78, or equal pipe hanger flange fastened with drive screws. Under wood floors, 3/8 inch hanger rods shall be hung from 2-inch by 2-inch by 1/4 inch angle clips 3 inches long, with 2, staggered 10d nails, clinched over joist.
  11. Hanger rod sizes for copper, iron, or steel pipe: 3/8 inch for pipe sizes 1/2 inch through 2-inch, 1/2 inch for pipe sizes 3-inch, 4-inch and 5-inch, 5/8 inch for pipe size 6-inch, and 3/4 inch for 8-inch and 10-inch pipe.
  12. Turnbuckles, if furnished, shall provide a load carrying capacity equal to that of the pipe hanger with which they are being installed.
  13. Pipe hangers shall be of the same size, or nearest larger manufactured size available, as pipe or tubing on which they are being installed.

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14. Hangers, clamps, and guides furnished for support of non-metallic pipe shall be padded with 1/8 inch thick rubber, neoprene, or soft resilient cloth.
15. Where special pipe-supporting requirements in the Specifications conflict with any standard requirements specified herein, the Specification requirements shall govern.
16. Vertical Piping:
  - a. Vertical pipe risers shall be securely supported with riser clamps of recognized type. Risers in reinforced concrete buildings shall be furnished with extension clamps fastened to pipe above each concrete floor slab with extended arms of clamp to rest on slab. Clamps shall be provided with lead or Teflon liners when installed on copper tubing. Clamps shall be plastic-coated when installed on non-ferrous pipe or tubing.
  - b. Copper tubing in sizes 1 ½-inches and larger and steel pipelines passing up through building shall be supported at each floor of building or every 15 feet whichever is less.
  - c. Copper tubing sizes 1 ¼-inches and smaller shall be supported at not intervals not more than 6 feet on center. Special provisions shall be installed for vertical lines subject to expansion and contraction caused by operating temperature differences.
  - d. Vertical cast iron pipelines shall be supported from each floor and at their base. Malleable iron or steel pipe clamps with minimum thickness of 1/4 inch shall be furnished and fastened around pipe for support.
17. Horizontal Piping:
  - a. Roof Mounted Piping: Pressure and non-pressure piping shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Block. Roller type supports shall be provided below and above pipe to prevent its dislodgement. Bottom of pipes shall clear the roof surface by 10 inches.
  - b. Domestic cold water piping, water supply and return piping, vacuum, compressed air piping, cast iron soil piping, galvanized steel vents, waste and downspout piping and glass to be supported with Tolco Figure 1, B-Line Figure B3100, or Grinnell Figure 260, hangers with rods, turnbuckles and inserts suitable for above hangers.
  - c. Maximum hanger and support spacing shall conform to CPC schedule for horizontal piping installed above grade.
18. A hanger or support shall be installed close to the point of change in the direction of a pipe run, in either a horizontal or vertical plane.

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19. When practicable, supports and hangers for cast iron soil pipe shall be installed as close as possible to joints and when hangers or supports are not located within one foot of a branch line fitting, an additional hanger or support shall be installed at fitting.
  20. In systems where grooved piping is used, couplings shall be provided with angle pattern bolt pads to comply with support and hanging requirements of ANSI/ASME B31.1, ANSI/ASME B31.9, and NFPA Pamphlet 13.
  21. Hangers supporting plastic piping shall not have sharp edges that can scratch the pipe as it moves due to expansion and contraction. Hangers with sharp edges may be used if they have an isolating substance such as felt between the pipe and the hanger.
- L. Flashings:
1. Each pipe or gas-fired equipment vent passing through roof shall be installed with waterproof flashing.
  2. Vent piping above roof shall be furnished with a combination counter-flashing sleeve and vandal-proof hood.

**END OF SECTION**

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## **SECTION 22 05 53 - PLUMBING IDENTIFICATION**

### **PART 1 – GENERAL**

#### **1.01 SUMMARY**

- A. Section Includes: Marking and identification on mechanical piping systems, ducts, controls, valves, and apparatus.
- B. Related Requirements:
  - 1. Division 01: General Requirements
  - 2. Section 21 13 13: Fire-Suppression Sprinkler Systems.
  - 3. Section 22 05 13: Plumbing Materials and Methods.
  - 4. Section 22 10 00: Plumbing.

#### **1.02 SUBMITTALS**

- A. Submit in accordance with Division 01 and Section 22 05 00: Plumbing Common Work.
- B. Submit product data and installation instructions for each item specified.
- C. Submit Samples of materials.

#### **1.03 QUALITY ASSURANCE**

- A. Comply with provisions of:
  - 1. Section 22 05 00: Plumbing Common Work
  - 2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.
  - 3. APWA: Uniform Color Code.
  - 4. IAPMO: Uniform Plumbing Code (UPC)

### **PART 2 – PRODUCTS**

#### **2.01 MATERIALS**

- A. General: Piping systems, controls, valves, apparatus, etc., except those that are installed in inaccessible locations in partitions, walls, and floors, shall be permanently identified.

#### **2.02 VALVES**

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- A. Furnish prepared chart or diagram for each piping system, indicating by identifying letter or model number of each valve in the system, its location, and function.
- B. Install charts in aluminum frame with clear glass front and secure on wall where designated by the Project Inspector.
- C. Bind copies of each chart in operating instructions manual.
- D. Provide each valve with a brass, aluminum, or plastic disc, not less than 1-1/4 inches diameter bearing engraved numbers corresponding to those indicated on chart. Fasten discs to valve with No. 14 brass wire.
- E. Provide an additional tag for safety valves and other valves that could be hazardous to the safety and health of occupants. Distinguish these tags from regular valve tags by color (such as yellow with black letters and marked "Danger"); submit Sample tag to the Architect for review.

### 2.03 INSTRUMENTS AND CONTROLS

- A. Identify panel-mounted instruments and controls with engraved Bakelite nameplates permanently affixed to panel boards.
- B. Identify alarm indicating devices and alarm reset devices by nameplates.
- C. Identify automatic valves, flow switches, and pressure switches, with embossed aluminum or plastic tape affixed to controller, indicating service and setting.

### 2.04 EQUIPMENT

- A. Identify each major piece of equipment with engraved Bakelite nameplates permanently affixed to the equipment, indicating the room numbers it services, Equipment identification designation shall be the same to its designation indicated on the "As-Built Drawings". Room numbers in the nameplates shall correspond to the final room numbers.

### 2.05 ABOVE GRADE PIPE IDENTIFICATION

- A. Identify pipes by means of colored labels with directional flow arrows and identification of the pipe content, in conformance to ANSI/ASME A13.1 or the UPC.
- B. Materials: Precoiled acrylic plastic with clear polyester coating, all-temperature, self-adhering, as manufactured by Brady, Brimar Industries, Seton, Stranco, Inc., or equal.
- C. Size:

Outside Diameter of Pipe or Insulation (in inches)	Length of Color Field (in inches)	Size of Letter (in inches)
¾ to 1 ¼	8	½

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1 ½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
over 10	32	3 ½

D. Locations:

1. On accessible piping, whether insulated or not (including mechanical rooms, attic and ceiling spaces); except that labels shall be omitted from piping where contained material is obvious due to its connection to fixtures (such as faucets, water closets, etcetera.).
2. Near each valve and branch connection in such accessible piping.
3. At each pipe passage through wall or floor.
4. At not more than 20 feet spacing on straight pipe run between bands required in 2 and 3 above.
5. At each change in direction.

E. Application: Install on clean surfaces free of dust, grease, oil, or any material that will prevent proper adhesion. Replace non-adhering or curling labels with new labels.

F. Color Schedule:

Content of Pipe	Legend	Background Color	Lettering Color
Domestic cold water	Domestic. C.W.	Green	White
Non-potable cold water	Caution: Non-potable Water Do Not Drink (1)(2)	Purple	Black
Domestic hot-water 140°F	Domestic H.W. 140°F	Blue	Black
Sanitary waste	San waste	Green	White
Sanitary vent	San vent	Green	White
Storm drain or downspout	Storm drain	Green	White
Indirect drain	Ind drain	Green	White
Vacuum, Compressed Air	Pump discharge	Green	White
Fire sprinkler supply	Fire Sprinkler supply	Red	White
Fire sprinkler drain	Sprinkler drain	Red	White
Fuel oil	Diesel oil	Yellow	Black
Gas	Gas	Yellow	White
Deionized	Caution: Water Do Not Drink	White	Blue

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	(1)(2)		
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### H. Notes on Schedule:

1. Note (1) indicates 2 ¼ inch by 1 inch yellow label with ½ inch letters reading UNSAFE WATER at one end of primary label.

Note (2) words should read "CAUTION: NONPOTABLE WATER DO NOT DRINK." with international *do not drink* symbol.

Note (3) words should read "CAUTION: RECLAIMED WATER DO NOT DRINK." with international *do not drink* symbol.

## 2.06 UNDERGROUND PIPE

### A. Detectable Marking Tape:

1. Provide and install detectable marking tape along buried piping. Tape shall be specifically manufactured for marking and locating underground utilities with electronic equipment. Tape shall be acid and alkali resistant, and manufactured with integral wires or foil backing, encased with protective cladding. Tape shall be a minimum of two inches in width.
2. Manufacturer: Reef Industries, Inc., Advantage Brands, Inc., Northtown Company, Mutual Industries, Inc., or equal.
3. Detectable marking tape shall be color-coded per APWA Color Code:
  - a. Yellow: Oil and gas.
  - b. Blue: Water, irrigation and slurry lines.
  - c. Green: Sewer and drain lines.

### B. Tracer Wire:

1. Solid copper wire type THWN, 12 AWG gauge, with heat and moisture resistant insulation.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. Correct detrimental conditions prior to commencing the Work of this Section. Install markers and identification tags as specified with materials and installation procedures recommended by manufacturer.
- B. Place tracer wire on top of non-metal utility lines allowing some slack. Do not wrap tracer wire around pipe. Fasten tracer wire in place at approximately 10 feet on centers with non-metal ties.

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1. Insulated tracer wire shall not come in contact with CPVC corrosive waste piping. Run wire above or next to CPVC piping.
- C. Install underground detectable pipe marking tape continuously buried 8 to 10 inches above the buried utility pipe. Wrap tape on pipe risers up to a height of 12 inches above grade.

### **3.02 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of them off the Project site.

**END OF SECTION**

**SECTION 22 07 00 - PLUMBING INSULATION**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Insulation for plumbing piping.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 22 05 00: Plumbing Common Work
  - 3. Section 22 05 13: Plumbing Materials and Methods.
  - 4. Section 22 05 53: Plumbing Identification.
  - 5. Section 22 10 00: Plumbing.

**1.02 REFERENCES**

- A. American Society for Testing and Materials International (ASTM):
  - 1. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.
  - 2. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - 3. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - 4. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - 5. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
  - 6. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
  - 7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 8. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. Underwriters Laboratories, Inc.
  - 1. UL 723 - Test for Surface Burning Characteristics of Building Materials.

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- C. National Fire Protection Association:
  - 1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- D. California Code of Regulation Title 24.
  - 1. California Green Building Standards Code.

### 1.03 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00: Plumbing Common Work Results.
  - 1. Complete material list of items to be furnished and installed under this Section.
  - 2. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements.
  - 3. Shop Drawings, catalog cuts and manufacturer's data indicating insulation, jacketing, adhesives, and coating. Insulating materials shall be certified by manufacturer to comply with the California quality standards for insulating materials.
  - 4. Display sample cutaway sections.
  - 5. Manufacturer's recommended method of installation procedures, which will become part of this Section.

### 1.04 QUALITY ASSURANCE

- A. Qualifications of Manufacturer and Installer, Materials, Fabrication, Execution, and Standard of Quality: Comply with provisions stated under Section 22 05 00: Common Work Results for Plumbing and Section 22 05 13: Plumbing Materials and Methods.
- B. Insulation Work shall be in accordance with the California Building Energy Efficiency Standards, CBC, and Uniform Mechanical Code and the California Green Building Standards Code.
- C. Test Ratings:
  - 1. Comply with provisions stated under Section 22 05 00 and 22 05 13 with emphasis on ASTM E84, NFPA 255, or UL 723. ASTM C167, ASTM C302, UL label or listing of satisfactory test results from the National Institute of Standards and Technology, or a satisfactory certified test report from an acceptable testing laboratory. Approval by the State Fire Marshal is required.
  - 2. Furnish labels, legibly printed with the name of the manufacturer or listings indicate that fire hazard ratings do not exceed those specified for materials proposed for installation. Flame spread index of not more than 25 and smoke developed rating not exceeding 50.

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3. Tests shall be performed on each item individually when insulation, vapor barrier covering, wrapping materials, or adhesives are installed separately at the Project site.
  4. Test insulation, vapor barrier covering, wrapping materials and adhesives as an assembly when they are factory composite systems.
- D. Regulatory Requirements: Insulation furnished and installed under this Section shall meet minimum legal requirements of the Building Energy Efficiency Standards adopted and incorporated in the California Energy Commission, Title 24, Part 2, Chapters 2 through 53 and the California Green Building Standards Code unless otherwise noted, for the piping,
- E. Chemically based products such as sealers, primers, fillers, adhesives, etcetera must meet the California air quality regulations.

### 1.05 PRODUCT HANDLING

- A. Protection, Replacement, Delivery and Storage: Comply with provisions stated under Sections 22 05 00: Plumbing Common Work Results and 22 05 13: Plumbing Materials and Methods.

## PART 2 – PRODUCTS

### 2.01 MATERIALS

- A. General:
1. Insulating material shall be fire resistant, non-corrosive, shall not break, settle, sag, pack or disintegrate under vibration, nor absorb more than 1 percent moisture by weight.
  2. Insulating material shall be furnished with thickness indicated in Table 1, and shall furnish thermal resistance in the range of R-4.0 to 4.6 in accordance with inch at 75 degrees F. For any other value of R, insulation thickness shall be calculated accordingly and submitted for review.
  3. Asbestos in any quantity in insulating material is not permitted.
  4. Provide insulation materials, adhesives, coatings, sealants, fitting covers, and other accessories with a fire hazard rating not to exceed 25 for flame spread, 25 for fuel contributed and 50 for smoke developed, except for materials listed as follows:
    - a. Nylon anchors for installing insulation to equipment.
    - b. Treated wood blocks.
  5. Flame-proofing treatments subject to moisture damage are not permitted.

TABLE 1 - MINIMUM PIPING INSULATION THICKNESS <sup>(1)</sup>

Insulation Thickness Required (in inches)

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Piping System Type	Temp. Range (degrees F)	Runouts up to 2 (2)	1 and less	1.25 to 2	2.5 to 4	5 to 6	8 and larger
Service Water Heating Systems (recirculating, piping supply and return)							
Hot Water	Up to 180	0.5	1.0	1.0	1.5	1.5	1.5
Condensate Drain from A/C Equipment:	Insulate condensate drain lines within building, in room, inside walls and above ceilings.	0.5	0.5	0.5	0.5	0.5	0.5

NOTES: (1) For piping exposed to ambient temperatures, increase thickness by 0.5 inch.

(2) Runouts to individual terminal units, not exceeding 12 feet in length.

- B. Lagging Adhesives: Shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Insulation finished with canvas shall be provided with laps adhered in accordance to manufacturer's recommendation. A finish coat of same material shall be applied to entire outer surface of lagging cloth at coverage specified by manufacturer.
- C. Canvas Jackets: Provide 6 ounce, in accordance with square foot minimum, 48 by 48 thread count canvas jacketing.
- D. Insulation Jackets:
- Exterior insulation exposed to weather shall be weatherproofed with Childers aluminum jacketing as basis of design, or Pabco, RPR, or equal. Jacketing shall be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16 inch corrugations. Smooth or embossed jackets may be permitted in special situations to match an existing installation. Jacketing shall be furnished with an integrally bonded moisture barrier over entire surface in contact with insulation. A minimum thickness of 0.016 aluminum jacketing is to be provided on ducts and piping. A minimum thickness of 0.020 shall be provided on tanks, equipment, and heat exchangers.
  - Insulated elbows, of 90 degrees and 45 degrees, with a nominal iron pipe size of ½ inch to 8-inch shall be provided with Childers aluminum Ell-Jacs insulation covers as basis of design, or Pabco, RPR, or equal, manufactured from 1100 aluminum alloy of 0.024 inch thickness. Insulated elbows with a nominal pipe size of 10-inch to 18-inch shall be provided with Childers 4-piece aluminum Ell-Jacs as basis of design, or Pabco, RPR, or equal.
  - Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Furnish Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company, Pabco, RPR, or equal.
- E. Adhesives: Adhesives shall be water based, UL Classified, meet the requirements of NFPA 90A and NFPA 90B, have been tested according to relevant ASTM requirements, and be acceptable to the State Fire Marshal. Name, type and method of installation shall be submitted for review.

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- F. Valve and Fitting Cover: When installed in conjunction with PVC jacketing, furnish Zeston 25/50 rated polyvinyl chloride fitting covers as manufactured by Johns Manville, Knauf Insulation, Speedline, or equal.

## 2.02 DOMESTIC HOT WATER PIPING SYSTEM INSULATION

- A. General: Insulate domestic hot water supply and return piping, including valves, strainers and fittings with insulation thickness as indicated on Table 1.

- B. Materials:

1. Classes of Insulation:

- a. Class A: Glass fiber molded pipe insulation suitable for service temperatures up to 850 degrees F. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, Knauf Redi-Klad 1000, Owens Corning FIBERGLAS Pipe Insulation SSL II-ASJ, or equal.
- b. Class B: Flexible open-cell melamine (foam insulation) suitable for service temperature -150 degrees F to 400 degrees F. Thermal conductivity at 75 degrees F, K= 0.26. Pipe insulation, one-piece pre-formed, laminated to heavy non-reinforced PVC jacket, with locking track, factory installed to jacket, to snap insulation and jacket onto pipe. Like TechLite 079 Series as manufactured by Accessible Products Co., or equal. Installation shall comply with manufacturers recommendations.
- c. Class C: Mineral fiber pipe insulation suitable for service temperatures up to 1200 degrees F. Pipe insulation shall be one-piece, preformed up to 3 inches thick, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be 8 pounds in accordance with cubic foot density by Roxul Techton 1200, Fibrex COREPLUS 1200, Industrial Insulation Group, LLC (IIG) MinWool-1200, or equal.

2. Locations and Class of Insulation Required:

TABLE 2 – LOCATIONS AND CLASS OF INSULATION REQUIRED

<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Equipment Room	A, B or C
Other Locations	A, B or C

3. Fittings on indoor piping shall be covered with flush, hand-wrapped Class A, B, or C insulation, to match the adjoining pipe insulation and covered with polyvinyl chloride fitting covers: Zeston 2000 25/50 by Johns Manville, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.

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4. Adhesive: Fibrous Adhesive to bond calcium silicate to itself and non-porous surfaces.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

- A. Except as specified herein, install material in accordance with recommendations of manufacturer. Do not install insulation materials until tests specified in other sections are completed. Remove foreign material such as rust, scale, or dirt. Surfaces shall be clean and dry. Always maintain insulation clean and dry.
- B. On cold surfaces where a vapor barrier must be provided and maintained, insulation shall be installed with a continuous, unbroken moisture and vapor seal. Hangers, supports, anchors, or other projections that are fastened to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. Surface finishes shall be extended in such a manner as to protect raw edges, ends, and surfaces of insulation.
- D. Pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where firestop or firesafing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed accordingly.
- F. Insulation shall not be installed in the following locations unless otherwise noted:
  1. On unions, flanged connections or valve handles.
  2. Over edges of any manhole, clean-out hole, clean-out plug, and to restrict opening or identification of access.
  3. Over any label or stamp indicating make, approval, rating, inspection, or similar data, unless provision is made for identification and access to label or stamp.

#### **3.02 INSTALLATION OF DOMESTIC HOT WATER PIPING SYSTEM INSULATION**

- A. General: Domestic hot water, tempered water supply and return piping and condensate return piping, after having been tested, shall be cleaned and insulated.
- B. Application: Insulate condensate return piping, domestic hot water supply and return, including tempered supply and return piping in accordance with manufacturer's instructions and as specified herein.
  1. Install insulation on valve bodies up to valve bonnet. Fill void in saddles, in accordance with Section 22 0513: Basic Plumbing Materials and Methods, with insulation and seal joints.

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2. Install insulating material to fittings, valves, and strainers and smooth to thickness of adjacent covering. Leave strainer clean-out plugs accessible. Covers fabricated from polyvinyl chloride shall be furnished.
- C. Insulation Jackets in Exposed Indoor Locations:
1. Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams 1 1/2-inch minimum. Finish entire jacket with coating of undiluted adhesive.
  2. Equivalent factory applied pre-sized, glass fiber reinforced, or glass fiber jackets may be furnished. Seal jacket seams with adhesive in accordance with manufacturer's instructions.
  3. Johns Manville Zeston 2000, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal, fitting covers may be furnished, with molded or segmented insulation equal to specified insulation applied to fittings. Secure covers in accordance with manufacturer's instructions.
  4. In addition to above requirements, cover exposed insulated piping within 8 feet above floors with 26 gage galvanized steel jacket. Omit jacket in areas accessible only to maintenance personnel, such as mechanical equipment rooms, utility corridors, accessible pipe tunnels and manholes.
- D. Concealed Indoor Locations: Cover insulation over fittings, valves, and strainers with canvas. Provide pipe insulation with factory or field applied standard jacket of 4 ounce minimum canvas, fiberglass cloth, or glass fiber reinforced jacket. Seal jacket laps with adhesive in accordance with manufacturer's instructions.
- E. Exposed Outdoors: In addition to canvas or fiberglass cloth cover, pipe insulation exposed to weather shall be provided with an additional 0.016 inches thick aluminum jacket with 2-inch lap connected with one inch hem overlap joint located on side of pipe and turned down to shed water. Jacket shall be strapped 12 inches on center with 1/2-inch wide stainless steel strapping and wing seals. Aluminum jacket shall be mitered to fit fittings.

### 3.03 CLEANUP

- A. Remove rubbish, debris, and waste materials and legally dispose of them off the Project site.

### 3.04 PROTECTION

- A. Protect the Work of this Section until Substantial Completion.

**END OF SECTION**

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**SECTION 22 10 00 - PLUMBING**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Labor, materials, tools, and equipment to install plumbing systems as indicated.
- B. Related Sections:
  - 1. Division 01 - General Requirements.
  - 2. Section 22 05 00: Plumbing Common Work.
  - 3. Section 22 05 13: Plumbing Materials and Methods.
  - 4. Section 22 05 53: Plumbing Identification.
  - 5. Section 22 07 00: Plumbing Insulation.
  - 6. Division 31 - Excavation.

**1.02 SUBMITTALS**

- A. Provide in accordance with Division 01 and Section 22 05 00: Plumbing Common Work.
- B. Provide necessary documentation to Owner for processing rebates for water efficient fixtures.

**1.03 QUALITY ASSURANCE**

- A. Unless otherwise noted, the California Plumbing Code is hereby made part of this section.
- B. Conform to provisions of Section 22 05 00: Plumbing Common Work.
- C. Manufacturer of plumbing products must be third-party certified to ANSI/NSF Standard 61, Section 9 certification, and ANSI/NSF 372 to demonstrate compliance with the federal requirements for lead contribution to drinking water, the Safe Drinking Water Act SDWA, and the California Health and Safety Code Section 116875

**1.04 PRODUCT HANDLING**

- A. Conform to provisions of Section 22 05 13: Plumbing Materials and Methods.

**PART 2 – PRODUCTS**

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**2.01 PIPING SYSTEMS**

- A. Insulation for Piping: Refer to Section 23 07 00: Plumbing Insulation.

**2.02 FIXTURES AND DRAINS**

- A. General: Fixtures specified shall be furnished complete with trim and fittings. Cast iron plumbing fixtures shall be acid resistant enamel and identified by casting letters "AR" or words "acid-resistant" into metal. Fixtures shall be white unless otherwise specified. Cast iron fixtures shall be white enamel inside and on back, rim and apron, with exposed unfinished surfaces painted white. Fixtures of the same general classifications shall be of same make.
- B. Finished Brass:
1. Unless otherwise specified, finished brass of a similar type shall be of the same manufacturer and model throughout buildings.
  2. Finished and exposed brass equipment, except floor, shower and urinal drains shall be chromium-plated and polished. Floor, shower and urinal drains, unless otherwise specified, shall be nickel-bronze metal.
- C. Traps, Trap Arms and Tailpieces:
1. Fixture traps shall be all cast brass, chromium-plated and polished. (No tubular traps). Exceptions as follows:
    - a. Traps that are an integral part of a fixture.
    - b. Traps concealed in floors, walls and furring.
    - c. Traps standard for service sinks and Industrial Shop equipment.
    - d. Laboratory traps and tailpieces shall be as specified in section 22-05 13 Plumbing Materials and Methods.
  2. Concealed traps and 17 gage tailpieces may be rough brass finish, except as otherwise specified. Laboratory traps and tailpieces shall be as specified in Section 22 05 13: Plumbing Materials and Methods. Furnish chromium-plated and polished cast brass wall flanges with setscrews and chromium-plated and polished brass casing on discharge side of each trap.
  3. Tailpieces shall be not lighter than 17 gage, brass, chromium-plated, and polished. Furnish and install chromium brass plated wall flanges with set screws and chromium-plated 20 gage brass casing on discharge side of each chrome-plated all cast trap.
- D. Faucet and Shower Valve Handles: Faucet and shower valve handles shall be solid brass, chromium-plated and polished, and fastened to their stems by Allen type hollow head stainless steel set screws through the side of the handle extending into

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the stem. Handles with sharp edges or projections shall not be furnished. At accessible fixtures: handles shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate handles shall be 5 pounds maximum.

**E. Fixture Supplies:**

1. Supplies for water heaters shall be non-plated rigid copper water tube with threaded adaptors for connections to valves and other threaded connections. All other supplies shall be chromium-plated brass with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
2. Exposed supplies for showers shall be chromium-plated brass pipe up to header with hospital threads or shall be furnished with fittings and valves, which completely cover threads.
3. Supplies to water closet tanks, lavatories, and drinking fountains shall be furnished with chromium-plated and polished screwed type angle compression stops with square shank stems and lock shields extending beyond stem. Instead of solid supply piping, polished chrome-plated risers of 3/8 inch outside diameter with ferrule stop end and metal nose piece may be furnished. The installation of braided stainless or easy hooker's supplies is not permitted. Exception: Supplies that rise vertically from floor shall be furnished with straight type instead of angle type stops.
4. Each supply or pipe that penetrates a finished surface and plumbing pipes passing through a countertop or part of a cabinet shall be furnished with a chromium-plated brass flange except flanges furnished by manufacturer of flush valves as an assembly.
5. Water supplies of plumbing fixtures shall be protected against back-siphonage in the event of a vacuum in the piping system.
6. Discharge outlets of supply faucets for lavatories and sinks shall clear top of overflow rim by at least one inch.
7. Toilet and urinal flush valves shall be furnished with recognized atmospheric vacuum breakers, installed a minimum of 6 inches above fixture.

**2.03 ACCESS PLATES (To cleanouts, valves, water hammer arrestors and hose faucets)**

**A. Schedule Numbers:**

AP-1: Square, unless otherwise noted, steel, prime coated; frame, 18 gage minimum. The door shall be 16 gage minimum with concealed hinge or be removable, with vandal-proof lock operated by Allen wrench.

(Specify for painted and stucco walls.)

SMITH	ZURN	ELMDOR	MILKOR	WATTS	MIFAB	JOSAM
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Fig 4760 AK	Z-1462- VP	DW-AKL	MOR DW AK1	CO-300- S-6	UA-A	58650-VP OR EQUAL
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- AP-2: Round type, stainless steel, vandal-proof, 5/16 inch No. 18 or 1/4 inch No. 20 flat-head machine screw into cleanout plug. Plate shall be prime coated minimum 18 gage steel or polished chrome-plated brass, 18-8 No. 302 stainless steel, or polished nickel bronze.

(To be specified for painted walls, screwed into cleanout plug.)

SMITH	ZURN	JOSAM	WADE	WATTS	MIFAB
4710U	Z-1469- VP	58600	8480R	CO-480- RD	C1400-RD-6

- AP-3: Square, polished face chrome-plated bronze, aluminum alloy or brass chrome-plated brass frame with 14 gage polished 18-8 No. 302 stainless steel or brass chrome-plated secured cover with vandal-proof screws.

(To be specified for tile walls.)

SMITH	ZURN	WADE	WATTS	MIFAB	JOSAM
4735U	Z-1460- VP	58630	CO-300- S-6	C1400-S- 3-6	58640-VP

**2.04 CLEANOUT ASSEMBLIES**

- A. Cleanout plug shall be line size.

- B. Schedule Numbers:

- CO-1: Iron body cleanout tee full line size up to 4 inches and round access plate, plugs shall be brass, countersunk with tapped boss for 5/16 inch No. 18 or 1/4 inch No. 20 screws. (Specify for finished walls at base of waste stack, above urinal and service sink.) AB&I and TYLER may be used as iron body cleanouts. The trim and accessories shall be Smith or Zurn.

SMITH	ZURN	WATTS	MIFAB	JOSAM
4532- U	Z-1446-BP	CO-460-RD	C1460-RD-6	58600-CO

- CO-2: Iron body with approved UPC plug, top and adjustable sleeve, cut-off ferrule, polished scoriaceous brass nickel bronze secured cover. AB&I and TYLER may be used as iron body cleanouts. Trim and accessories shall be Smith or Zurn (To be specified for finished floors inside buildings, in covered areas, and in concrete paving.)

Square:

SMITH	ZURN	WATTS	MIFAB	JOSAM
4053L-U-NB	ZN-1400-T	CO-200-S	C1220-S-1-	55000-

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Round:

SMITH	ZURN	WATTS	MIFAB	JOSAM
4033-L-U-NB	ZN-1400	CO-200-R	C1220-1-6	55000-1

CO-3: Secured cover, extra heavy-duty, adjustable sleeve, cut-off ferule, UPC. Brass approved type plug, scoriaceous tractor type cover.

(To be specified for areas outside building on concrete paving.)

SMITH	ZURN	WATTS	MIFAB	JOSAM
4233-U	ZN-1400-HD	CO-200-RX-4	C1220-4-6	55000-22

CO-4: Tapped soil tee with brass plug, full line size.

(Specify for above grade, outside building at base of exposed downspout.)

SMITH	ZURN	WATTS	MIFAB	JOSAM
4512	Z-1445-BP	CO-460	C1460	58910

CO-5: Raised threaded head brass plug.

(To be specified for yard box YB-3.)

ZURN	WAATS	SMITH	JOSAM
Z-1470-A	CO-590	4285	58540-20

**2.05 DIELECTRIC UNIONS**

A. Schedule Numbers:

- Dielectric style Unions using ferrous and no-ferrous metals are prohibited. Dielectric flanges are admitted for use – see DU-2.

DU-1: Lead Free Brass union with 6-inch Lead Free Brass nipple.

DU-2: Lead Free Brass union or Lead Free Brass flanged fittings are to be used in between pipes made of dissimilar metals to prevent accelerated corrosion and deterioration in the piping systems due to galvanic and stray current.

WATTS	NIBCO
LF3100M3	733-LF

**2.06 FIXTURES****Plumbing - 221000**

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- A. Schedule Numbers: See Drawings for Specifications.

### 2.07 FLEXIBLE HOSES

- A. Schedule Numbers:

FLH-1: Braided stainless steel metal hose (for gas use). US Flex, Metraflex, Nelson Dunn or equal.

FLH-2: Braided bronze metal hose (for non-pressure condensate connection use). US Flex, Metraflex, Nelson Dunn or equal.

### 2.08 FLUSH VALVE ASSEMBLY

- A. Schedule Numbers:

Valves shall be furnished so that flush will remain constant and not require any adjustment.

1. Each flush valve shall be provided with a loose key, square shank, lock shield angle service stop connected to flush valve with a union connection.
2. Provide 17 gage pressed brass escutcheons for wall and fixture. Escutcheons shall be fastened to not turn or rattle.
3. Each flush valve shall be furnished with a vacuum breaker providing one inch opening to atmosphere, which will not leak under any degree of back pressure and will not restrict rate of flow more than 10% at 10 pounds pressure and will operate noiselessly.
4. Tailpiece shall not be lighter than 17 gage and shall be part of flush valve assembly.
5. Exposed metal parts of flush valve assembly shall be chromium-plated on a brass or copper base.
6. See drawings for specifications.

### 2.09 LAVATORIES

- A. Access compliant faucets for Lavatories: Force to activate controls shall be no greater than 5 pounds. Self-closing metering, when specified, remains open for 10 seconds minimum when activated.
- B. Exposed trim shall be free from sharp edges or points. Fixture shall be furnished with other listed manufacturer specified trim. Instead of solid supply pipe, polished

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chrome-plated risers, 3/8 inch outside diameter with ferrule stop end and metal nosepiece may be furnished.

- C. Insulate cold water, hot water and drain lines under all access compliant lavatories with approved type insulation.

PLUMBEREX	LAV-GUARD	TRU-Bro
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- D. Supply: Brass Craft #HSTR1720A-CB-C

- E. Traps: Chicago #327 XCP 1-1/4-inch grid drain or equal

- E, See plans for specifications.

**2.10 P-TRAPS**

- A. Schedule Numbers:

PT-1: Cast brass complete, chrome-plated.

ZURN	AB&A	KOHLER
Z-8712-LC	107	K-9018

**2.11 SINKS and TRIM**

- A. Access compliant faucets for sinks: Force to activate controls shall be no greater than 5 pounds.

- B. Exposed brass nuts shall be chrome-plated. Refer to the Fixture Supplies paragraph of this section.

- C. For access compliant sinks: Insulate cold water, hot water and drainpipes under sinks with approved type insulation.

PLUMEREX	LAV GUARD	Tru-Bro
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- D. Schedule Numbers: See plans for specifications.

**2.12 SERVICE STOP GAS VALVES**

- A. Schedule Numbers:

SGV-1: Bronze/Brass, 3/4-inches to 2-inch IPS (WOG) water, or gas – full port ball valve. CSA approved.

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(To be specified for A/C units on roofs.)

WATTS	NIBCO	WILKINS
LFFBV-4	F-510-CS-R-66-FS	Model 850

SGV-2: Cast iron, 2-inch to 4-inch flanged ball valves (WOG) water, or gas. CSA approved.

(To be specified for larger heating equipment.)

WILKINS	NIBCO	WATTS
Model 850	F-510-CS-R-66-FS	G4000M1

SGV-3: Lubricated plug gas valve, 3/4-inch to 2-inch IPS valve.

To be specified for use after gas meter headers, gas regulators, and isolation valves for building isolation, individual floor level isolation, and boiler rooms.)

NORDSTROM	WALWORTH	RESUN
142	1786	1430

SGV-5: Lubricated plug gas valve flanged type 2 ½-inch and larger valve.

(To be specified for use after gas meter headers, gas regulators, isolation valves for buildings isolation, individual floor level isolation and boiler rooms.)

NORDSTROM	WALWORTH	RESUN
142	1786-F	1431

## 2.13 STOP VALVES

- A. Stops shall be loose key type, ½-inches IPS inlet and outlet chrome-plated brass casting, except as noted.
- B. Schedule Numbers:

STV-1: Angle:

CHICAGO,	CRANE	NIBCO
442-LKABCP	8.5113.	77

STV-2: Partition:

CHICAGO	T& S BRASS
1771-ABCP	B-1028

STV-3: Straight Type, with Loose Key:

CHICAGO	CRANE	T&S BRASS
45-LKABCP (1/2	8-5111	B-O418

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inch)		
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**2.14 WATER CLOSETS**

- A. General: Water closets shall be vitreous china with SloanTec™ Glaze and Polyvinyl chloride bolt caps. Fixtures with auto-flush valves shall be provided with manual override button.
- B. Schedule Numbers: See plans for specification.

**2.15 WATER HAMMER ARRESTORS**

WHA-1: Lead Free Water Hammer Arrestor provided for Headers for Lavatories, Wash Sinks, Wash Fountains, Kitchen Sinks, Service Sinks, Urinals and Water Closets. For sizing purposes size according to manufacturer's recommendations.

SIOUX CHIEF	PPP	JR SMITH	WATTS	JOSAM
655 and 656 SERIES	SC SERIES	5005 TO 5050 SERIES	Series LF05 and LF15M2	75000

**2.16 YARD BOXES**

- A. Schedule Numbers:

YB-1 Yard Boxes: 14 ¾-inch by 20-inch by 12-inch, cast concrete, with cast iron traffic cover marked "GAS"

(For use over gas stops).

BROOKS 36-H MB with No. 36-T Cast iron Cover	EISEL 363.5	OR EQUAL
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YB-2: Same as YB-1, marked "WATER" (For use over water valves).

BROOKS 36- H MB with No. 36-T Cast iron Cover	EISEL 363.5	OR EQUAL
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YB-3: Same as YB-1, marked "SEWER"

BROOKS 36- H MB with No. 36-T Cast iron Cover	EISEL 363.5	OR EQUAL
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**2.17 HEIGHT OF FIXTURES**

- A. Heights for standard fixtures.

Fixture	Inches
Water Closets	15 to 17

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Lavatories	32
Drinking Fountains	38 to 43
Wash Sinks	30
Urinals, lip height	24
Shower Heads From tip of shower head to finish floor.	72
Shower valves	48

**B. Heights for access compliant fixtures.**

Fixture	Inches
Toilets, center line from wall	17 to 18
Toilets, height to top of seat	17 to 19
Lavatories, sink top height	34 maximum
Lavatories, sink knee clearance	27 minimum
Urinals, lip height	17 maximum
Urinals, flush handle height	44 maximum
Drinking fountains, bubbler height.	36 maximum
Drinking fountains, knee clearance	27 minimum
Wash Sink	Per Drawings
Shower Valves	Per CBC
Shower Seat	Per CBC
Shower Head (adjustable) Bar	Per CBC

**PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Examine areas and conditions under which Work of this section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

**3.02 INSTALLATION**

A. General:

1. Unless otherwise specified, plumbing fixtures, equipment and appliances that require connections to plumbing line shall be connected. This shall include fixtures specified or indicated as furnished by others, furnished by

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- Owner, or specified in other related sections. Install supplies, stops, valves, traps, wall flanges, or pipe casing for connection of this equipment.
2. Install equipment as indicated on reviewed and accepted Shop Drawings.
  3. Avoid interference with Work of other trades. Do not deviate from Drawings without review of the Architect.
- B. Examination: Check each piece of equipment in the system for defects verifying that parts are properly furnished and installed.
- C. For piping Work, refer to Section 22 05 13: Plumbing Materials and Methods.
- D. Plumbing Fixture and Equipment Installation:
1. Unless otherwise indicated, fixtures shall be installed with 5/16-inch brass bolts or screws of sufficient length to securely fasten fixture to backing, wall, or closet ring.
  2. Fixtures installed against concrete or masonry walls shall have their hangers fastened with 5/16-inch brass bolts, Philip Shield type anchors, or 2 unit cinch anchors. Wood or plastic plugs are not permitted.
  3. Fixtures installed against wood or metal stud walls shall have their hangers fastened to metal backing plates with 5/16-inch brass bolts screwed into plate. Fixture hangers for urinals shall be fastened centered vertically on metal backing plate with three 5/16 brass bolts each for small individual hangers and six, for larger one-piece hangers. Lavatories shall be hung with not less than four 5/16-inch brass bolts or not less than five 1/4 inch brass bolts. Each sink hanger shall be hung with not less than four 5/16-inch brass bolt or not less than five 1/4 inch brass bolts.
  4. Pan type drinking fountains shall be hung with 5/16-inch cadmium plated bolts with a bolt in each bolt opening in hanger. Hangers for pan type drinking fountains shall provide 2 inches (plus or minus 1/4 inch) between pan and wall. Spaces due to irregularities between fixtures and tile walls shall be neatly filled with white cement or silicone filler.
  5. Backing for hanging of plumbing fixtures and equipment shall be installed in supporting wall at time rough piping is installed. The backing for stud walls shall be steel plate 1/4 inch thick, not less than 4 inches wide. Backing for urinals shall be 1/4-inches thick by 6-inch-wide steel plate. Steel plate shall be attached to stud at each end of plate and to each stud it crosses. Plate shall be attached to metal studs by bolting with two 1/4 inch U-bolts per stud with bolts through plate and around stud flange or by welding with a 1/8-inch fillet weld full width of stud flange, top and bottom of plate. At wood studs, plate shall be carefully recessed flush with face of stud and attached to each stud with 2 No. 14 flat-head wood screws, 2 inches in length into pre-drilled 1/8-

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inch holes. Backing for stud walls supporting wall-hung closets shall be as detailed.

6. Rough-in for fixtures, equipment and appliances shall be as indicated on Drawings and as specified, including those items indicated as furnished by others, furnished by Owner, or future capacity. When connections to equipment from capped or plugged lines are required, caps or plugs shall be removed at time equipment is set and stops or valves installed, and connections provided as specified.
7. Piping materials for trap arms shall be Brass, Cast Iron or DWV copper
8. Piping shall be stubbed out to the exact location of fixtures and stubs shall be installed symmetrical with fixtures. Hot and cold-water supplies for center set faucets on lavatories shall be installed on 8-inch centers, unless otherwise specified or required.

### E. Cleanouts in Drain, Waste, Vent and Sewer Lines:

1. Cleanouts shall be installed at locations stated in the California Plumbing Code and accessible at following locations:
  - a. At locations above first floor as stated on construction documents and 5 feet outside of the building.
  - b. Install an accessible main line upper terminal cleanout in all restrooms above water closet overflow. (Install above upper terminal water closet where there is more than one water closet in a restroom).
  - c. Above faucets of each sink with brass plug.
  - d. Above service sink with brass plug.
  - e. At each Drinking Fountain with brass plug.
  - f. In vertical line at base of each downspout connected to an underground storm drain system extend cleanout to exterior of building.
  - g. At upper end of a horizontal vent line when any part of horizontal line is below overflow level of fixture it serves.
  - h. Not to exceed 100-foot intervals in sewer and waste lines exterior of building.
  - i. At property line connection.
  - j. Where indicated on Drawings.
2. Cleanouts shall be extended to grade as follows:

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- a. Not to exceed 100-foot intervals in straight runs of pipe outside buildings.
  - b. At horizontal changes of direction in aggregate greater than 135 degrees (underground).
  - c. At property lines.
  - d. Where cleanouts occur under concrete.
  - e. Where marked for future connections.
3. Cleanouts in building shall be extended to floor level or above floor level or above floor level in walls or furring when cleanouts are not accessible or where clearance is less than 18 inches.
  4. Cleanouts in finished areas in building shall be concealed except that cleanouts above service sinks in janitor's rooms or closet, and cleanouts above service sinks or in exposed piping in boiler or heater equipment rooms, may be exposed. Cleanouts for urinals shall be installed above the urinal and shall terminate behind an access plate.
  5. Cleanouts in floors of covered areas and those extended to grade in concrete areas shall be floor level type with extensions body brass plugs and detachable nickel-bronze or aluminum alloy scoriated.
  6. Concealed cleanouts in vertical lines shall be service weight soil cleanout tees with brass plugs and round cover plates unless otherwise specified or indicated. A snug fitting sleeve of galvanized sheet metal shall be placed around hub of tee and shall extend to flush with finished soil, or cleanout shall be extended to finished wall.
  7. Cleanouts extended from below floor to a wall or furring or on horizontal lines above floor that terminate at a wall or furring shall be iron body type with brass plugs and round cover plates.
  8. Cover plates over cleanouts in painted walls shall be steel, bonderized and prime coated. Cover plates cover cleanouts in tile walls shall be chromium-plated brass or nickel bronze. Plates shall be attached to cleanout plugs with 5/16-inch No. 18 or 1/4 inch No. 20 stainless steel vandal-proof type screws. Plates shall be one inch larger in diameter than fitting opening.
  9. Cleanouts at bases of downspouts shall be tapped soil tees with brass plugs as hereinafter specified, full size of line.
  10. Cleanouts extended to grade in exterior sewer lines other than floors or concrete areas shall be a cleanout assembly with secured top, extra heavy-duty, adjustable sleeve, cut-off ferrule, countersunk threaded brass plug and scoriated tractor type cover.

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11. Other cleanouts shall be iron body type.
12. Cleanout extensions shall be no-hub cast iron soil pipe. Exterior cleanouts, those in concrete excepted, shall terminate in a 14-inch by 6-inch-thick concrete block with cleanout assembly and top of block flush with finish grade.
13. Fittings in lines utilized as cleanouts shall be approved soil fittings including no-hub pipe. Tees and crosses in vent headers excepted.
14. Pipe joint compound shall not be installed on cleanout plug. After lines are tested and approved, each cleanout plug shall be removed, greased, and replaced.

### **3.03 EXCAVATION, TRENCHING AND BACKFILLING**

- A. Perform trenching, excavation, and backfilling required for Work of this section as specified herein and in Division 31.

### **3.04 SERVICE CONNECTIONS**

- A. Determine exact location of required water, drain, and sewer connections and provide proper connections.
- B. Potable water lines shall be purged completely before connecting to sources of water for the Project. Determine quality of water supply before connection.

### **3.05 WATER HAMMER ARRESTORS**

- A. Install water hammer arrestors indicated on Drawings and in following locations (only non-ferrous arrestors may be installed in copper water system):
  1. Water lines to lavatory headers, water closet and urinal headers, service sinks, kitchen sinks, wash fountains, drinking fountains, laboratories with medical type faucets and on wash sinks having three or more stations and all other quick closing fixture such as clothes washers, as close to fixture as possible.
  2. Between the last two fixtures when three or more fixtures, other than those listed in Number 1 above, are served by a common header.
- B. When possible, an arrestor shall be installed in the wall or furring. When an arrestor is installed in wall or furring, furnish an access plate large enough to permit removal of arrestor. Access plate shall be a minimum of 2 inches larger in each direction than the arrestor.
- C. Fixture water lines shall be provided with mechanical water arrestor hammer dampening devices. Air chambers are not approved.

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**3.06 CONDENSATE DRAINS - FROM AIR CONDITIONING UNITS**

- A. Connect drain piping from drain pan of air conditioning unit to condensate disposal location indicated. When coil or unit housing is shock or vibration isolated, connection shall be furnished through a flexible connector not less than 10 inches long. Drain line shall pitch to flow out at not less than one inch in 8 feet. Drain line shall not be reduced smaller than unit outlet connection.
- B. Condensate drain piping installed within the building whether in air-conditioned space or not shall be insulated. Refer to Section 22 0700: Plumbing Insulation, for type of material required.
- C. Condensate Trap:
  - 1. A condensate trap shall be installed for each air conditioning coil. Trap shall be assembled from 2 brass unions: one between A/C unit and inlet of trap, and one at outlet of trap that connects to main drain.
  - 2. Trap configuration shall be per manufacturer's recommendations based on total unit casting static pressure (simulated plugged filter condition), but not less than 3-inch water seal.
  - 3. Running trap design is not permitted.
  - 4. Secondary drain shall not be trapped.
- D. Condensate trap shall be checked at equipment operational tests for proper water drainage flow from air conditioning unit. Cooling condensate pan shall be filled with water, filters covered with plastic (plugged filter simulated), unit panels replaced, and unit motor running at design condition. Pan shall drain without hesitation to bottom of inlet connection. Tests are made prior to installation of the ceiling.
- E. Secondary Overflow Drain:
  - 1. Drain pan installed underneath air conditioning units in concealed ceiling space or units that incorporate dam fitting shall be furnished with secondary drain piped to outside planter area with outflow location clearly visible.
  - 2. If outside building location is not available or feasible, secondary drains shall be piped to a classroom sink, if sink is not available pipe to a room corner away from cabinets, computers, desks, doorways/entrances or stairs.
  - 3. Secondary vertical pipe that penetrates through suspended ceiling shall be furnished with a coupling or threaded adapter so ceiling tile can be removed without damage.

**3.07 GAS SERVICE**

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- A. Above Grade Service: Pipe shall be steel, hammered, free of dirt and scale, and blown out with oil-free air or nitrogen to a clean, dry condition. Piping shall not be installed in or through a ventilation duct or plenum.
- B. Underground Service, Gas approved (yellow) Polyethylene Plastic Pipe: Refer to Section 22 05 13: "Plumbing Materials and Methods".
  - 1. Pipes shall be joined with polyethylene fitting and joined together by thermal fusion in accordance with procedures recommended by Polyethylene plastic pipe and fitting manufacturer.
  - 2. Plastic pipe shall be installed not less than 30 inches below grade..
  - 3. Underground Warning Tape shall be installed 12 inches above buried gas piping. Warning tape shall be yellow with caution statement as follows: "CAUTION – BURIED GAS LINE BELOW".
  - 4. Plastic pipe shall not be installed in or under a building or structure. Pipe shall be installed under bituminous surfacing or compacted soil area, free from large stones. Pipe may be installed under sidewalks or driveways if no joint occurs. Pipe installed under paved covered areas wider than 40 feet shall be installed in ventilated conduits extending 2 feet past paving.
  - 5. Pipe shall be installed on a 6 inches deep sand bed. After the required pressure-leak test, the pipe shall be covered with sand not less than 6 inches thick.
  - 6. Piping shall not support weight of valves, metal fittings or other items. Pipe shall be installed strain free.
  - 7. Plastic pipe fittings shall not be stored or left exposed to sunlight. Pipe in open trenches shall be shielded. A sand envelope of 6 inches minimum shall be placed around pipe, with exception of joints, until inspection by IOR is completed. Protection for the pipe shall be provided when necessary to leave the pipe exposed overnight.
  - 8. Installer of piping is required to have training and to have attained a certification. Non-trained/Non-certified installer must contact the manufacturer or manufacturer's representative to provide on-site fusion training and certification, prior to work commencement
  - 9. Polyethylene plastic pipe shall connect to a steel epoxy coated anodeless type riser to minimum of 6 inches above grade, when exiting the underground installation and transitioning to steel pipe connection.
  - 10. Where a steel pipe riser passes into a structure or building, a double swing or double-offset joint shall be furnished. Pipe shall pass into structure 6-inches above grade and through a sleeve with a minimum one-inch clearance. An isolation valve is required before the pipe enters the building.

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**3.08 CLEANING - PLUMBING PIPING SYSTEMS AND FIXTURES**

- A. Plumbing lines and fixtures shall be flushed to remove dirt and foreign material until water runs clear and no foreign substance or odor is present. Strainers and screens on faucets shall be removed during this cleaning operation.
- B. After satisfactory cleaning of strainer and screen replacements has been witnessed by the Project Inspector, post and maintain signs stating: "CAUTION - Water at this construction project has not yet been certified for human consumption." Signs shall be furnished with letters at least 1/2 inch in height and shall be conspicuously posted at entrances to the Project site. Signs shall be paneled, black and yellow, in conformance with OSHA Section 1910.1455.

**3.09 DISINFECTING DOMESTIC WATER PIPING SYSTEMS**

- A. Newly installed or replaced piping and/or fixtures dispensing potable water shall be disinfected and undergo an approved bacteriological analyses before water systems are allowed for public use.
- B. Work shall be performed by Technicians Certified by the American Water Works Association (AWWA) and/or the State of California Department Health Services, Grade II Water Treatment Operator Certification or higher issued by the Department of Health Services (DHS) for the State of California. Comply with Title 22, Code of Regulations Division 4, Chapter 13, and Article 2 Operator Certification Grades.
- C. Method:
  - 1. A Reduced Pressure Backflow assembly shall be installed to protect from cross contamination of the local water purveyor's meter service supply when at any time there is any type of water connection with the piping to be disinfected (Chlorinated) and the water meter service supply.
  - 2. System is to be flushed to remove any materials that may have entered the system.
  - 3. Using a chemical feed metering pump and a chlorine tank, the chlorine solution is injected into the water system.
- D. Disinfection and De-chlorination procedure (24 or 3 Hour Contact Time):
  - 1. 24-hour Test Method:
    - a. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
    - b. Piping system shall then be adequately flushed with water to remove any particles and eliminate air pockets.
    - c. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 50 PPM. A water flow meter provided by the water

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treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.

- d. Chlorine residual test will be taken at all appropriate points and outlets to verify 50 PPM residual levels.
- e. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 24 hours.
- f. After 24 hours, chlorine residual levels will again be tested at various points throughout the system to insure a minimum of 25 PPM residual. If the system has not met the minimum of a 25 PPM residual, the above disinfection process shall be repeated.
- g. After satisfactory completion of the residual testing, flush out system until Hach or equivalent test reveals the water outlets have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.
- h. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating the water system is not safe for consumption until laboratory results are complete and meet these specifications.

### 2. 3 Hour Test Method:

- a. If the water systems must be turned on for use as soon as possible, a 3 hours chlorine contact time to allow for disinfection is permitted with the OAR's approval.
- b. Prior to disinfection, post signs on all water outlets of the system to be disinfected. Sign or tags shall read, "Water System Being Chlorinated- "Danger Do Not Drink Water" or similar warning.
- c. Piping system shall be then adequately flushed with water to remove any particles and eliminate air pockets. Using the continuous feed method, sodium hypochlorite conforming to ANSI/ AWWA B300 will be injected into the water system at a minimum of 200 PPM. A water flow meter provided by the water treatment technician will be used to determine the rate of injection and a chlorine test kit, Hach or equivalent, will be used to monitor the residual.
- d. Chlorine residual test will be taken at all appropriate points and outlets to verify 200 PPM levels. The chlorinated system shall be shut down for any use and the chlorinated water shall remain in the water system for retention of 3 hours.
- e. After satisfactory completion of a 3 hour disinfection period, flush out system until Hach or equivalent test reveal the water outlets

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have a free chlorine residual concentration less than 0.5 PPM. The procedure shall be in accordance with the AWWA standard C651-05.

- f. The OAR may allow temporary use of the water system for construction purposes pending results of the bacteriological test analysis. Sign or Tags shall be left on all outlets stating the water system is not safe for consumption until laboratory results are complete and meet these specifications.

**E. Bacteriological Test:**

1. After final flushing and satisfactory results from the residual free chlorine concentration test, Bacteriological test samples shall be collected. The intent of the following is to provide insurance for an accurate representation to a complete Bacteriological test of the water system. At least two samples shall be taken from each floor of each building.
2. Bacteriological test samples shall be delivered to a State of California Department of Health Services Certified Laboratory to perform qualitative and quantitative bacterial analyses on the water samples for the presence of any Total Coliform bacteria and Plate Count. This count must be less than 500 cfu/mL.
3. The procedure shall be repeated if it is shown by bacteriological examination made by an approved agency that the level of Disinfection does not meet these specifications.
4. After satisfactory results for the bacteriological test are provided to the OAR, warning sign or tags shall be removed.

- F. Drinking Fountain and Bottle Filler Lead Test: After installation of Drinking Fountain or Bottle Filler, and successful Disinfection Test, shut off domestic water supply line feeding the fixture, and inform OAR. OAR will coordinate with the Contractor to conduct lead detection test and mitigate, as necessary. Do not remove related construction warning sign and tags.

**3.10 VALVES ON PLUMBING SYSTEM**

- A. Furnish and install gates, ball, globes, angles, and check valves on plumbing Work at following locations whether indicated on drawings or not.
- B. Hot and cold valves shall be:
  1. Lead free complying with AB1953.
  2. Above the ground copper water system, 2-inch and larger, may utilize Victaulic butterfly valves and fittings for their connections. A 2-inch or larger Victaulic valve may be in a wall if an adequately sized access panel is provided for maintenance or removal.



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- C. Valves shall be accessible and installed within an access panel approximately 3 feet above floor and no more than 7 feet above floor, or in a marked yard box to prevent tampering.
1. Immediately after each water meter, in addition to any valve furnished by utility company, there shall be an accessible valve on the inlet side for a strainer assembly, dual backflow device assembly and/or possibly a dual pressure reducing valve assembly.
  2. A gate or ball valve on each water supply before it enters the building. Valves shall be accessible from outside the building and shall be installed in a marked yard box, unless otherwise indicated on drawings. Ball valves 2 ½-inch size or larger shall omit gate valve handle and furnish 2-inch square operating nut.
  3. At multi story buildings, provide an isolation-valve or multiple valves for both hot and cold water in access panel to isolate and control each floor level.
  4. For classrooms, shops, offices and boiler or mechanical room, install a gate or ball valve to control hot and cold water lines to each group of fixtures, a group of fixtures shall be 2 or more fixtures in the same room. When practical, valves shall be installed on the same wall as a group of fixtures. Valves shall control only fixtures in rooms in which they are installed.
  5. For restrooms, a gate or ball valve shall be installed in each restroom to isolate the hot and cold water supply into a restroom regardless of the number of fixtures. These valves shall control and be accessible only from within the restroom in which fixtures are installed. Valves shall be installed on the same wall as the group of fixtures it serves. Valves shall control only fixtures in restroom in which they are installed. Back to back restrooms shall be isolated separately and individually.
  6. Install a gate or ball valve on each building branch line, which serves two or more fixtures, when these fixtures are not provided with a group isolation valve as specified above. These valves shall be located approximately 3 feet but not more than 7 feet above the finish floor.
  7. Install a gate, ball valve or partition stop for a drinking fountain or a group of drinking fountains.
  8. Install a gate, ball valve or partition stop for hot and cold water supply to plumbing fixtures with no accessible supply stops, such as wall mounted faucets.
  9. Install a gate, ball valve or partition stop for stops adjacent to, and controlling water flow to each sill cock and hose bib except as follows:

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- a. Valves or stops will not be required for individual hose bibs when these hose bibs are on a branch line serving only hose bibs and branch line is furnished with a shut-off valve.
10. Install a loose key angle stop, on each exposed fixture supply, and for each flush valve unless otherwise specified,
11. Install gate or ball valve at each location where a water line is connected to a piece of equipment other than items mentioned above.
12. Install a check valve on each hot water return line where it connects to a hot water storage tank or a water heater.
13. Handles, hand wheels (including dishwasher fill valve handles) and operating nuts shall be furnished of steel, brass, or cast iron and shall be removable. Unless specified to be loose key type, handles shall be securely fastened to their stems. On exposed outdoor valves, omit operating handles and provide operating nuts.
14. Provide a handle or a key for each five, or fraction thereof, loose key valves, bibs, or stops and deliver them to the project OAR.

### 3.11 VALVES - GAS SERVICE

- A. A gas readily accessible shut-off stop shall be installed on each gas line entering a building immediately prior to the point it enters the building. Unless otherwise specified or indicated, shut-off valves for lines entering a permanent structure, buildings or portable buildings, shall be installed in a vertical riser above grade.
  1. Gas shut off valve for portable buildings – A dedicated Gas shut off valve shall be provided in a marked Yard Box, for each portable building to facilitate relocation/removal of building without the need to shut off gas to entire school.
- B. Gas Shut off valve within a building – A gas shut off valve with handles shall be accessible and serviceable within an access panel. Install valve minimum 3 feet above floor but less than 7 feet above floor.
- C. In addition to locations specified, gas shut off valve shall be installed at following locations:
  1. Install a lubricated plug gas shut off valve on any line connected to gas main or header at master assembly.
  2. Install a lubricated plug gas shut off valve before entering any building or structure.
  3. Install a gas valve on each outlet, in addition to any gas stop furnished with equipment.

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4. Service to laboratory gas cocks shall be furnished with a special precision check valve, located downstream from gas stop servicing room outlet at each laboratory cock. Unless otherwise specified, 1/8-inches bore shall be provided for each outlet cock.
  5. Install a gas shut-off valve on each gas line serving 2 or more gas outlets in the same room. Service stop shall be installed not more than 7 feet above floor, and shall be in the room it serves.
  6. Install a gas shut-off valve on the inlet side of each gas pressure regulating valve.
  7. Gas shut-off valves to be furnished with equipment.
  8. Install gas shut-off valve at not more than 1,000 foot intervals on each gas main.
  9. At multi-story buildings, provide gas-shut off valve(s) to isolate and control each floor or level. Install valves in a concealed manner in walls with access panels.
  10. Gas shut-off valves in classrooms and locations subject to tampering shall be protected while remaining accessible.
- D. When a gas-shut off valve adjacent to gas-fired equipment is indicated in Contract Documents it shall be furnished and installed as part of the Work of this section.
- E. When electrical wall switches with emergency push button are specified for controlling gas outlets at Laboratory Classrooms, provide main shut-off gas valve with normally closed electric solenoid valve within an accessible access panel.

### 3.12 ELECTROLYSIS PREVENTION

- A. Brass nipples, 6 inches, with recognized brass unions; flanges shall be furnished and installed at locations described herein. Flanges shall be installed with complete insulating component consisting of gasket bolt sleeves and bolt washers. Dielectric insulators shall be installed at following locations:
1. Where special applications indicated on Drawings require an insulation flange or brass union, with 6-inch brass nipple to be installed in a condensate line, or steam line, flange insulation shall be of a high temperature type, suitable for continuous operation at temperatures up to 220 degrees F. for condensate and 400 degrees F. for steam.
  2. Where steel or cast iron in ground connects to copper or brass piping above ground, transition from steel or cast iron pipe to copper or brass pipe shall be provided in an accessible location.
  3. Underground dielectric connections shall be furnished in accessible yard boxes.

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4. Above ground dielectric connections shall be exposed; or if in finished rooms shall be in accessible access boxes.

**3.13 UNDERGROUND PIPE MARKERS**

- A. Pipe markers shall be furnished according to Section 22 0553: "Plumbing Identification"
- B. Underground Caution Tape shall be placed 12 to 18 inches above the utility line. The Caution Tape shall be a designated color and marked with the appropriate name for the specific type of utility pipe as follows:
  1. Yellow – with the words: CAUTION GAS LINE BELOW
  2. Blue – with the words: CAUTION WATER LINE BELOW

**3.14 DEPTH OF SEWER LINES**

- A. Minimum depth of below grade sewer lines shall be 24 inches to centerline of pipe. Sewer lines shall slope  $\frac{1}{4}$  inch per foot minimum, unless otherwise indicated. The minimum depth at Owner property line shall be 6 feet, unless otherwise required.

**3.15 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of Project site.

**3.16 PROTECTION**

- A. Protect Work of this section until Substantial Completion.

**END OF SECTION**

## SECTION 23 0130 - HVAC AIR DUCT CLEANING

### PART 1 - GENERAL

#### 1.01 SECTION INCLUDES

1. Supply system.
2. Return system.
3. Exhaust and Transfer system.
- A. Related Requirements:
  1. Division 01 - General Requirements.
  2. Section 23 3000 - Air Distribution.
  3. Section 23 0700 - HVAC Insulation.
  4. NADCA Standard ACR.
  5. NADCA General Specification for the Cleaning & Restoration of Commercial HVAC Systems.
  6. UL181 Standard for Factory-Made Air Ducts and Air Connectors.

#### 1.02 DEFINITIONS

- A. ACR: Assessment, Cleaning, and Restoration of HVAC Systems.
- B. ASCS: Air systems cleaning specialist.
- C. HEPA: High Efficiency Particulate Arrestance.
- D. HVAC: Heating, Ventilation and Air Conditioning.
- E. NADCA: National Air Duct Cleaners Association.
- F. OEHS: Office of Environmental Health & Safety.
- G. SDS: Safety Data Sheet.
- H. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- I. UL: Underwriters Laboratories.

#### 1.03 SUBMITTALS

- A. Qualification Data for ASCS as indicated on NADCA General Specification.
- B. Strategies and Procedures Plan before starting the work.
- C. Cleanliness Verification Report at the project completion.

#### 1.04 QUALITY ASSURANCE

- A. ASCS Qualifications:
  1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
  2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 "Standard for Factory-Made Air Ducts and Air Connectors" requirement.
- C. Cleaning Conference: Conduct conference at Project site. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

### PART 2 - PRODUCTS (Not Used)

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine HVAC air-distribution equipment systems to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Assessment and Recommendation" according to current NADCA ACR Standard.
- C. Prepare written report listing conditions detrimental to performance of the Work.

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- D. Proceed with work only after unsatisfactory conditions have been corrected, and OAR's approval has been obtained.

**3.02 PREPARATION**

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
  - 1. Supervisor contact information.
  - 2. Work schedule including location, times, and impact on occupied areas.
  - 3. Methods and materials planned for each HVAC component type.
  - 4. Required support from other trades.
  - 5. Equipment and material storage requirements.
  - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection. Refer to Construction Documents for quantities.
- C. Comply with current NADCA ACR Standard, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

**3.03 CLEANING**

- A. Comply with current NADCA ACR Standard Requirement.
- B. Do not use any chemicals in the process of cleaning unless there is a significant reason. Using any kind of chemicals is subject to the OAR's approval. Prior to the application of any chemical, ASCS is required to submit SDS document of proposed cleaning materials to OAR in order to obtain product approval from OEHS. Do not apply any material unsafe for hard metal surfaces.
- C. Systems and Components to be Cleaned by a qualified ASCS:
  - 1. Air devices for supply and return air.
  - 2. Ductwork:
    - a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
    - b. Return-air ducts to the air-handling unit.
    - c. Exhaust-air and Transfer-air ducts.
- D. Perform cleaning before air balancing or mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- E. Use duct-mounted access doors, as required, for physical and mechanical entry and for inspection.
  - 1. Install additional duct-mounting access doors to comply with duct cleaning standards. Comply with requirements in Section 23 3000 "Air Distribution" for additional duct-mounting access doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection. Replace damaged and deteriorated flexible ducts. Comply with requirements in Section 23 3000 "Air Distribution" for flexible ducts.
  - 3. Disconnect and reconnect flexible connectors as needed for cleaning and inspection. Replace damaged and deteriorated flexible connectors. Comply with requirements in Section 23 3000 "Air Distribution" for flexible connectors.
  - 4. Replace damaged fusible links on fire and smoke dampers. Replacement fusible links shall be same rating as those being replaced. Comply with requirements in Section 23 3000 "Air Distribution" for fusible links.

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5. Remove and reinstall ceiling components to gain access for duct cleaning. Clean ceiling components after they have been removed and replaced.
- F. Particulate Collection and Odor Control:
  1. Where venting vacuuming system inside building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size or greater particles.
  2. When venting vacuuming system outside building, use filtration to contain debris removed from the HVAC system and locate exhaust down wind and away from air intakes and other points of entry into building.
- G. Clean the following metal-duct system components by removing visible surface contaminants and deposits:
  1. Air outlets and inlets: registers, grilles, and diffusers.
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  3. Air-handling-unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  4. Coils and related components.
  5. Return-air ducts, dampers, and actuators, except in ceiling plenums and mechanical room.
  6. Supply-air ducts, dampers, actuators, and turning vanes.
  7. Dedicated exhaust and ventilation components.
- H. Mechanical Cleaning Methodology:
  1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
    - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
  2. Cleaning Mineral-Fiber Insulation Components:
    - a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to current NADCA ACR Standard. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
    - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests, refer to current NADCA ACR Standard.

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- c. Fibrous materials that become wet shall be discarded and replaced in-kind.
  3. Clean coils and coil drain pans according to current NADCA ACR Standard. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  4. Provide operative drainage system for wash-down procedures.
  5. Biocidal Agents and Coatings: Apply Biocidal agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply Biocidal agents and coatings according to manufacturer's written recommendations and OEHS registration listing after the removal of surface deposits and debris.
    - a. When used, Biocidal treatments and coatings shall be applied after the system is rendered clean.
    - b. Apply Biocidal agents and coatings directly onto surfaces of interior ductwork.
    - c. Sanitizing agent products shall be registered by the OEHS as specifically intended for use in HVAC systems and ductwork.
  6. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- I. Cleanliness Verification:
  1. Verify cleanliness according to current NADCA ACR Standard, "Verification of HVAC System Cleanliness" Section.
  2. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
  3. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and re-inspected.
  4. Additional Verification:
    - a. Perform surface comparison testing or NADCA vacuum test.
    - b. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
  5. Prepare a written cleanliness verification report. At a minimum, include the following:
    - a. Written documentation of the success of the cleaning.
    - b. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
    - c. Surface comparison test results if required.
    - d. Gravimetric analysis (nonporous surfaces only).
    - e. System areas found to be damaged.

### 3.04 CONNECTIONS

- A. Reconnect ducts to fans and air-handling units with existing flexible connectors after cleaning ducts and flexible connectors. Replace existing damaged and deteriorated flexible connectors.
- B. For fans developing static pressures of 5-inch w.g. and higher, cover replacement flexible connectors with loaded vinyl sheet held in place with metal straps.



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- C. Reconnect terminal units to supply ducts with existing flexible ducts or replace damaged and deteriorated existing flexible ducts with maximum 12-inch lengths of new flexible duct.
- D. Reconnect diffusers to low-pressure ducts with existing flexible ducts or replace damaged and deteriorated existing flexible ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Reconnect existing and new flexible ducts to metal ducts. Comply with requirements in Section 23 3000 "Air Distribution" for flexible ducts.

### 3.05 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to current NADCA ACR Standard, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Section 23 3000 "Air Distribution" Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 23 3000 "Air Distribution".
- D. Replace damaged insulation according to Section 23 0700 "HVAC Insulation".
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Reseal fibrous-glass ducts. Comply with requirements in Section 23 3000 "Air Distribution".

### 3.06 FIELD QUALITY CONTROL

- A. Gravimetric Analysis: Sections of metal-duct system, chosen randomly by OAR may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
  - 1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
  - 2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal-duct system shall be re-cleaned and re-verified with no additional cost to OWNER.
- B. Verification of Coil Cleaning: Cleaning shall restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.
- C. Report results of tests in writing.

**END OF SECTION**

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## **SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC**

### **PART 1 – GENERAL**

#### **1.01 SUMMARY**

- A. Section Includes:
  - 1. This Section provides the basic mechanical requirements that apply to the Work of Division 23.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Division 26: Electrical.

#### **1.02 REGULATORY REQUIREMENTS**

- A. Materials, fabrication, equipment, and installation shall comply with industry standards and code requirements. Where manufacturer's recommendations exceed industry standards, the manufacturer's recommendation shall establish the minimum standard. As a minimum, standards from the following organizations shall apply:
  - 1. AMCA - Air Movement and Control Association.
  - 2. ANSI - American National Standards Institute.
  - 3. ASME - American Society of Mechanical Engineers.
    - a. ASME Boiler and Pressure Vessel Code.
    - b. ASME B31 - Code for Pressure Piping.
  - 4. AHRI - Air-Conditioning, Heating, and Refrigeration Institute.
  - 5. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers.
  - 6. ASTM - American Society for Testing and Materials.
    - a. ASTM A53 - Specification for Welded and Seamless Pipe.
  - 7. CSA - Canadian Standards Association.
  - 8. FM Global - Factory Mutual Global
  - 9. IAPMO - International Association of Plumbing and Mechanical Officials.
  - 10. NFPA - National Fire Protection Association.
  - 11. OSHA - Occupational Safety and Health Administration.
  - 12. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
  - 13. UL - Underwriters Laboratories Inc.
  - 14. Intertek (ETL Certification).
- B. Materials, fabrication, equipment, and installation shall comply with federal, state, and local codes including, but not limited to, the following:

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1. CBC, California Building Code, and CMC, California Mechanical Code.
    - a. Latest edition as adopted by the City of Los Angeles, the County of Los Angeles, and the State of California including amendments effective on the Effective Date of the Contract.
  2. California Code of Regulations, Title 8, Industrial Relations, Division 1, Chapter 4, Division of Industrial Safety.
  3. OSHA - Occupational Safety and Health Administration.
  4. CDPH – California Department of Public Health.
  5. SCAQMD - South Coast Air Quality Management District.
- C. Specifications or Drawings shall not be construed to permit deviation from the requirements of governing codes unless approval has been obtained from legally constituted authorities having jurisdiction, and the Architect. The Contract Documents may contain more stringent requirements than those legally required.
- D. Permits and Fees: Refer to the General and Supplementary Conditions.

### 1.03 SUBMITTALS

- A. Provide submittals in accordance with Section 01 3300: Submittal Procedures and with specific requirements of Division 23 sections, as applicable.
- B. After Architect's approval, the above information shall become the basis for inspecting and testing materials and actual installation procedures performed in the Work.
- C. Shop Drawings: Submit one additional copy when control diagrams having line voltage connections are indicated. Shop Drawings shall be specifically prepared for the Work of this Project. Drawings prepared in accordance with requirements of Section 01 3113: Project Coordination and Section 01 3300 may be provided by the Architect to serve as a background for the Shop Drawings. Shop Drawings shall comply with the requirements of Section 01 3113 and Section 01 3300 and shall indicate at a minimum:
  1. Complete system layout of equipment, components, ductwork, and piping, indicating service clearances, duct and pipe sizes, fitting types and sizes, top or bottom of duct and pipe elevations, distances of ducts, pipes and equipment from building reference points and hanger / support locations. All the above items shall be coordinated on the shop drawings according to the requirements of Section 01 3113.
  2. Schedule and description of equipment, ductwork, piping, fittings, valves, dampers, and controllers.

### 1.04 PROJECT RECORD DOCUMENTS

- A. Comply with provisions of Section 01 7700: Contract Closeout.
- B. Project Record Drawings:
  1. Provide a complete set of mechanical and control system drawings in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks and plotter pen color/line thickness settings on CD-ROM. Also submit one set of full size reproducible plots on vellum and three sets of prints.

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2. Before Contract Completion, deliver corrected and completed prints to the OAR. Delivery of project record documents to the OAR does not relinquish responsibility of furnishing required information omitted from project record documents.
- C. Operation and Maintenance Manuals:
1. Submit operation and maintenance manuals in required form and content. If no revisions are required, furnish one additional copy. If revisions are required, one copy shall be returned with instructions for changes; perform such changes and return manuals. Manuals shall be bound in accordance to Section 01 7700. Deliver manuals to the OAR. Submit an electronic copy of the entire manual in PDF file format.
  2. Contents of Manual:
    - a. Title sheet with Project name, including names, addresses and telephone number of Contractor, installer, and related equipment suppliers.
    - b. Manufacturer's operating instructions including, but not limited to, the following:
      - 1) Identification of components and controls.
      - 2) Pre-start checklist and start-up procedures.
      - 3) Normal operation settings and checklists.
      - 4) Pre-shut down checklist and shut down procedures.
      - 5) Trouble shooting checklist and guidelines.
      - 6) Recommendations for optimum performance.
      - 7) Warnings and safety precautions on improper or hazardous operational procedures or conditions
    - c. Manufacturer's product data and parts and maintenance booklet for each item of equipment furnished under Division 23 that includes the following as a minimum:
      - 1) Manufacturer's model, identification and serial numbers.
      - 2) Exploded view of assembly drawings identifying each component or part with the relevant part number.
      - 3) Directory of manufacturer's representatives, service contractors and part distributors.
      - 4) Maintenance and trouble-shooting instructions, including schedule for preventive maintenance, periodic inspection and cleaning criteria.
    - d. Project Record Drawings: Complete set of mechanical and control system drawings in 50 percent reduced print format shall be furnished with the manual. Submit the above record drawings on CD-ROM in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks, and plotter pen color/line thickness settings.
    - e. Testing, Adjusting, and Balancing reports: Submit as specified in Section 01 4525.

- f. South Coast Air Quality Management District (SCAQMD) permits to install and operate boilers, water heaters and other fuel burning equipment and third-party source test reports as required by SCAQMD to allow start-up and operation of equipment.
- g. **Los Angeles County** industrial waste permits.
- h. Valve directory complete with location, function, size, and model of each valve with reference to the project record drawings.
- i. Equipment and component identification chart complete with location, function, size, and model of each equipment or component with reference to the project record drawings.

#### **1.05 COORDINATION**

- A. Contract Documents indicate extent and general arrangement of Work under Division 23. Contractor shall coordinate work in accordance with Section 01 3113 requirements and make adjustments as required to provide maximum headroom, a neat arrangement to keep passageways and openings clear to provide accessibility and provisions for maintenance, and to meet code requirements.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.
- B. Do not store plastic pipe or materials in direct sunlight.

#### **1.07 PRELIMINARY OPERATION**

- A. OAR may require any portion of mechanical Work to be operated before Substantial Completion. Such operation shall be in addition to regular tests, demonstrations and instructions required under the Contract Documents, and shall be performed as required.
- B. Notify the Project Inspector at least 24 hours in advance of lighting or re-lighting pilots.

#### **1.08 TRAINING OF OWNER PERSONNEL**

- A. Training of Owner's personnel shall include:
  - 1. A minimum of 8 hours of on-site overview of the overall Mechanical System.
  - 2. Refer to Division 23 sections for specific training on each of the components of the Mechanical System.
  - 3. A minimum of 8 hours of on-site overview identifying location and function of all Control Valves and Actuator assemblies.
  - 4. A minimum of 40 hours of (in classroom) software training for a minimum of 20 District personnel on EMS/BMS if such systems are utilized in the project. Training shall be conducted at control contractor training facility with computer setup for each person attending.
- B. Contract shall include the cost of training Owner operation and maintenance personnel in operating, adjusting, maintenance, trouble-shooting, and Project site repair of each component, equipment, or system provided under this Contract.

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- C. Operational and maintenance training shall be conducted on the Project site, unless indicated otherwise.
- D. Upon completion of Owner training, a completion certificate indicating the nature of the training and a description of the systems, complete with equipment and component lists shall be issued to each trainee. The certificate should be issued in duplicate with one copy retained by OAR.
- E. An attendance sheet with the names and signatures of all participants attending the training shall be submitted to the OAR and kept as part of the project documents.

### **1.09 GUARANTEES AND DAMAGE RESPONSIBILITY**

- A. Sound of water flowing in piping shall not be transmitted to building structure. Operation of mechanical system shall not produce operational sounds that can be heard outside of rooms enclosing apparatus or equipment.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS AND EQUIPMENT**

- A. Unless otherwise specified, materials and equipment shall be new, in good and clean condition. Equipment, materials, and components shall be of the make; type and model number noted on Drawings or specified. Pieces of equipment of the same type shall be by the same manufacturer.
- B. Whenever an item is listed by a single proprietary name, with or without model number and type, it shall be for purpose of design only, to indicate characteristics and quality desired. Proprietary designation listed on Drawings, or listed first in Specifications, is used as a basis for design to establish a standard for quality and performance and space requirements.
- C. HVAC equipment products from different manufacturers are never identical. Equipment approved as being equal is interpreted as being equivalent in capacity, performance and quality. The dimensions, weight, configuration and utility requirements could be quite different from the equipment used as the basis of design. Due to these differences, additional coordination and adjustments by the Contractor are required. For the equipment to be deemed truly equal, the additional coordination and adjustments by the Contractor should not incur any additional cost to the Owner and any additional labor to the design team.
- D. Equipment and materials indicated or required to be installed outdoors shall be of the type that is designed, manufactured, listed or approved by authorities having jurisdiction for outdoor installation by being resistant to the adverse effects of weather. All the additional protective measures against outdoor weather required by the manufacturers' installation instructions and prevalent practice shall be provided.
- E. For substitution of materials or products, refer to the General Conditions.

## **PART 3 – EXECUTION**

### **3.01 SERVICE INTERRUPTIONS, OFF-SITE, GAS AND WATER**

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- A. Schedule Work so there shall be no service interruptions of existing systems or systems during normal hours of operation of affected systems and facilities.
- B. When service interruptions are mandatory, arrange in advance with the OAR as to time and date of such interruptions.
- C. Systems, which are interrupted, shall be returned back into operation in such manner that they will function as originally intended.

### **3.02 CUTTING, NOTCHING, AND BACKING**

- A. Conform to California Building Code, Title 24, Part 2, for notches and bored holes in wood and for pipes and sleeves embedded in concrete and for cuts in steel, as detailed on structural Drawings.
- B. Where pipes or ducts pass through, or are located within one inch of any construction element, install a resilient pad, 1/2 inch thick minimum, to prevent contact.
- C. Furnish all necessary provisions for recesses, chases, and accesses and provide blocking and backing as necessary for proper reception and installation of mechanical Work.

### **3.03 LOCATION OF PIPING AND EQUIPMENT**

- A. Location of piping, apparatus and equipment as indicated on Drawings is approximate and shall be altered to avoid obstructions, preserve headroom, and provide free and clear openings and passageways.
- B. Trenches parallel to footings shall not be closer than 18 inches to the face of footings and shall not be below a plane having a downward slope of 2 horizontal to one vertical, from a line 9 inches above bottom of footing.
- C. Pipe in tunnels shall be installed close to one side of tunnel to provide maximum space for passage. Pipe shall not be installed through crawl hole unless otherwise specified or detailed on Drawings.
- D. Place equipment in locations and spaces indicated, disassemble and/or reassemble equipment as required by Project conditions.

### **3.04 TESTS AND TESTING**

- A. Tests shall be as required under the applicable sections of Division 23, including this Section.
- B. Tests required by other sections of the Contract Documents include the following:
  - 1. Test and balance of mechanical equipment and systems: Refer to Section 01 4525: Testing, Adjusting, and Balancing for HVAC.
  - 2. Hydrostatic test of boilers: Refer to Section 01 4525: Testing, Adjusting, and Balancing.
  - 3. Test of smoke and fire detectors: Refer to Division 26: Electrical.
- C. Additional tests may be required in the case of products, materials, and equipment if:
  - 1. Submitted items are altered, changed, or cannot be determined as exactly conforming to the Contract Documents.
  - 2. Performance testing and results may also be required on certain items which are as specified, including fan, and pump performance.
- D. Piping Tests:

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1. Perform tests required to demonstrate that operation of mechanical systems and their parts are in accordance with Specifications covering each item or system, and furnish materials, instruments and equipment necessary to conduct such tests. Tests shall be performed in presence of the Project Inspector, and representatives of any governmental agency having jurisdiction. Work shall not be concealed or covered until required results are provided.
2. If required tests are not performed, Owner may provide in accordance with the Contract Documents.
3. Pressure gages furnished in testing shall comply with CPC. Air shall be bled from lines requiring hydrostatic or water tests.
4. Systems shall be pressure-tested in accordance with pipe testing schedule below. Pipe test shall indicate no loss in pressure after a minimum duration of 4 hours at test pressures indicated. Where local codes require higher test pressures than specified herein for fire sprinkler systems, local codes shall govern.
5. Fuel gas lines shall be first tested with piping exposed, before backfilling trenches or lathing; second with piping in finished arrangement, backfilled and paved where required, and walls finished.
6. Refrigerant piping may be tested with a halide detector or calibrated electronic testing equipment.
7. Piping systems may be tested as a unit or in sections, but entire system shall successfully meet requirements specified herein, before final testing by the Project Inspector.
8. Repair of damage to pipes and their appurtenances or to any other structures resulting from or caused by these tests, shall be provided.

E. Pipe Testing Schedule:

System Tested	Test Pressure (psig)	Test With:
Steam piping, hot water heating system piping and chilled water piping	150	Water
Vacuum pump or condensate pump discharge and condensate return piping	150	Water
Refrigeration piping		
R-22	400	Dry nitrogen
R-134a	300	Dry nitrogen
R-401a	300	Dry nitrogen
R-401b	300	Dry nitrogen
R-404a	500	Dry nitrogen
R-407c	500	Dry nitrogen
R-410a	600	Dry nitrogen
R-507	500	Dry nitrogen
Radiant panel piping	150	Water

F. Equipment Performance Assurance Tests:

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1. Before operating any equipment or systems, a thorough check shall be performed to determine that systems have been flushed and cleaned as required and that equipment has been properly installed, aligned, lubricated, and serviced. Factory instructions shall be checked to verify installations have been completed and recommended lubricants have been installed in bearings, gearboxes, crankcases, and similar equipment. Particular care shall be furnished in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Equipment shall also be checked for damage that may have occurred during shipment, after delivery, or during installation. Damaged equipment, products, and materials shall be replaced or repaired as required.
  2. Upon completion of the above, adjust the system settings to within normal operating conditions to prevent the system from being damaged upon start-up.
  3. Run-test the equipment after start-up for five consecutive days. Tests shall include operation of heating, ventilating, and air conditioning equipment and systems for a period of not less than two 8 hour periods at 90 percent of the full specified heating and cooling capacities. If equipment passes, install new filters. If equipment fails, it shall be adjusted and retested until system meets all applicable codes.
  4. Equipment Start-up Reports: For each equipment or system on which start-up is performed, submit 8 copies of start-up report for review by the Architect.
    - a. The start-up report shall include the manufacturer's standard start-up form completed and signed by the start-up technician.
  5. Provide, maintain, and pay costs for equipment, instruments, and operating personnel as required for specified tests.
  6. Provide electric energy and fuel required for tests.
  7. Final adjustment to equipment or systems shall meet specified performance requirements.
  8. Equipment, systems, or Work deemed defective during testing shall be replaced or corrected as required. Test until satisfactory results are provided.
- G. Specific Coordinated Plan for Test and Balance:
1. Provide a narrative of the operational intent that clearly describes the function and sequence of operation of each component, equipment, or system installed. Instruct designated Owner personnel in the operation of the installed systems.
  2. Prior to final test and balance, mechanical equipment and systems shall be operated and tested as indicated in Paragraph 3.04.F above to demonstrate satisfactory overall operation of the installed systems.
  3. Immediately before starting tests, air filter media shall be cleaned or renewed. Roll-type filters shall be advanced to provide new clean media. Cleanable type media shall be thoroughly cleaned and re-oiled with new, clean oil as recommended by manufacturer if they are of viscous impingement type. Disposable type filters shall be replaced with new filters. Replaceable media shall be replaced with new media.
  4. An accurate means of measuring air flow and temperatures shall be furnished to balance air supply, return, and exhaust systems so uniform temperatures occur in every room and design airflow is obtained through registers, diffusers, and grilles.

5. Systems shall be adjusted to provide airflows indicated including maximum fresh air and maximum return air. Dampers shall be checked for proper settings and operation. Air and water inlet and leaving temperatures at coils shall be checked. Complete operational data including airflows, room temperatures, fan speeds, motor currents, plenum, and duct static pressures shall be tabulated.
6. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 23 0513: Basic HVAC Materials and Methods.

### **3.05 NOISE AND VIBRATION REDUCTION**

- A. Correct noise or vibration caused by mechanical systems. Provide all necessary adjustments to specified and installed equipment and accessories to reduce noise to the lowest possible level
- B. Correct noise or vibration problems caused by failure to install work in accordance with Contract Documents. Include all labor and materials required as a result of such failure. Pay for re-testing of corrected noise or vibration problems by the project acoustical consultant including travel, lodging, test equipment expenses, etc.

### **3.06 PROTECTION, CARE AND CLEANING**

- A. In addition to storage criteria of the General Conditions, and provisions under Section 01 5000: Construction Facilities and Temporary Controls, the following shall be provided:
  1. Provide for the safety and good condition of materials and equipment until Substantial Completion. Protect materials and equipment from damage.
  2. Protect installed Work.
  3. Replacements: In case of damage, immediately provide repairs and/or replacements as required.
  4. Protect covering for bearings, open connections to tanks, pipe coils, pumps, compressors and similar equipment.
  5. Interior of ductwork shall be maintained free of dirt, grit, dust, loose insulation, and other foreign materials.
  6. Air handling equipment shall not be operated until building is cleaned and air filters are installed.
  7. Fixtures, piping, finished brass or bronze, and equipment shall have grease, adhesive, labels, and foreign materials removed. Chromium, nickel plate, polished bronze or brass Work shall be polished. Glass shall be cleaned inside and out.
  8. Before initial start-up and again before Substantial Completion, piping shall be drained and flushed to completely remove grease and foreign matter. Pressure regulating assemblies, traps, strainers, boilers, flush valves, and similar items shall be thoroughly cleaned. Tag system with an information tag listing responsible party and date of element, before initial start-up and again before Substantial Completion. Compressed air, oil, and gas piping shall be blown out with oil-free compressed air or inert gas. Refrigerant piping shall be cleaned as specified.

**END OF SECTION**

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**SECTION 23 0513 - BASIC HVAC MATERIALS AND METHODS**

**PART 1 – GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. This Section prescribes basic materials and methods generally common to the Work of Division 23.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Division 07: Thermal and Moisture Protection: Polyvinyl-Chloride Roofing.
  - 3. Division 23: Heating, Ventilating, and Air-Conditioning.
  - 4. Division 26: Electrical.
  - 5. Section 31 2323: Excavation and Fill for Utilities.

**1.02 SUBMITTALS**

- A. Provide in accordance with Division 01, Section 23 0500 and specific requirements of each section of Division 23.

**1.03 QUALITY ASSURANCE**

- A. Standards: Comply with applicable national, state, and local codes and standards: ASTM, ASME, and ANSI. Federal Specifications, AWWA, CISPI, NFPA, FM Global, UL, CPC (California Plumbing Code), CMC (California Mechanical Code), CSA.
- B. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production as reviewed by the Architect.

**1.04 COORDINATION**

- A. Coordinate related Work in accordance with provisions of Section 01 3113: Project Coordination.

**PART 2 – PRODUCTS**

**2.01 GENERAL**

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- A. Provide the following products if they are indicated in the Contract Documents or if they are required for the proper installation, function or operation of equipment, systems or components indicated in the Contract Document.
- B. Provide the following products as a complete assembly with required accessories for a complete and functioning entity in compliance with governing codes and applicable standards as specified in Section 23 0500, manufacturer's instructions or as required.
  - 1. Omission of minor details in the Contract Documents does not waive and/or otherwise relinquish compliance with the above requirements.

### **2.02 MANUFACTURERS AND MATERIALS (NA)**

## **PART 3 – EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and conditions under which Work of this Section shall be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

### **3.02 INSTALLATION**

- A. Provide all materials and equipment for the Work. Furnish and install necessary apparatus, parts, materials, and accessories.
- B. Pipe Installation:
  - 1. Install piping parallel to wall and provide an orderly grouping of proper materials and execution.
  - 2. Piping shall clear obstructions, preserve headroom, provide openings and passageways clear, whether indicated or not. Verify the Work of other Divisions to avoid interference.
  - 3. If obstructions or the Work of other Divisions prevent installation of piping or equipment as indicated by the Drawings, perform minor deviations as required by the Architect.
  - 4. Install piping after excavation or cutting has been performed. Piping shall not be permanently enclosed, furred in, or covered before required inspection and testing is performed.
  - 5. Exposed polished or enameled connections from fixtures or equipment shall be installed with no resulting tool marks or threads at fittings. Residue or exposed pipe compound shall be removed from exterior of pipe.

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6. Piping shall be concealed in chases, partitions, walls, and between floors, unless otherwise directed or specifically noted on Drawings. When penetrating wood studs, joists, and other wood members, provide such members with reinforcement steel straps of Continental Steel & Tube Co., ULINE, Independent Metal Strap, or equal.
7. Reduce fitting where any change in pipe size occurs. Bushings shall not be furnished unless specifically reviewed by the Architect, or indicated on Drawings.
8. Piping subject to expansion or contraction shall be anchored in a manner, which permits strains to be evenly distributed. Swing joints or expansion loops shall be installed. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping. Seismic loops required at all building separations.
9. Immediately after lines have been installed, openings shall be capped or plugged to prevent entrance of foreign materials. Caps shall be left in place until removal is necessary for completion of installation.
10. Couplings shall not be installed except where required pipe runs between other fittings are longer than standard length of type of pipe being installed and except where their installation is specifically reviewed by the Architect.
11. Water piping shall be installed generally level, free of traps, unnecessary offset, arranged to conform to building requirements, clear of ducts, flues, conduits, and other Work. Piping shall be arranged with valves installed to provide for complete drainage and control of system. Piping shall not be installed which causes an objectionable noise from flow of water therein under normal conditions. Refer to Section 23 0500: Common Work Results for HVAC.
12. Water lines may be installed in same trench with sewer lines, provided bottom of water line is 12 inches minimum above top and to the side of sewer line.
13. Hot and chilled water circulating piping installed for space heating or cooling shall pitch up to a high point at a slope of 1/4 inch in 10 feet in the direction of flow. Where supply and return lines are exposed, both lines shall pitch in same direction. Otherwise, where possible, lines shall pitch up toward compression tank.
14. Changes in pipe sizes shall be furnished with eccentric reducers, flat on top. Offsets to clear obstruction shall not be installed so as to produce air pockets.

### C. Pipe Sleeves and Plates:

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1. Provide and install pipe sleeves of Schedule 40 black steel pipe or Schedule 40 PVC plastic pipe in concrete or masonry walls, footings, and concrete floors below grade. Provide and install adjustable submerged deck type sleeves at locations where pipes pass through concrete floors, except concrete slab floors on grade, and at locations where soil pipe for floor type water closets passes through concrete floors.
  2. Sleeves shall provide 1/2 inch clearance around pipes, except plastic pipe shall have 1-inch clearance. Caps of deck type sleeves shall be removed just prior to installation of pipe. Area around sleeves shall be smooth and without high or low spots. Sleeves in walls shall not extend beyond exposed surface of wall. Sleeves in concrete floors and walls shall be securely fastened to forms to prevent movement while concrete is being placed.
  3. Piping installed on a roof shall clear the roof surface by 10 inches minimum, with or without insulation. Bottom of individual fittings may infringe on 10 inches clear space but not groups of fittings or fittings located within 27 inches of each other.
  4. Stiles shall be provided to facilitate crossing of piping when parallel piping runs are laterally greater than 12 inches out-to-out, or any pipe is higher than 18 inches, and more than 40 feet long or runs between 2 or more major pieces of equipment or housings greater than 20 feet apart. Stiles shall be not less than 20 inches wide with a minimum tread depth of 10 inches. Where stiles are required, they shall be located so greatest obstructed distance is 30 feet.
  5. Where pipes pass through waterproofed walls, floors, or floors on grade, sealant with Link-Seal Modular Seals, or equal, between pipe and sleeve to provide a waterproof joint. Where earth is in contact with pipe on both sides of a wall or foundation, the waterproof joint is not required. Commercial rubber compression units may be furnished instead of sealed sleeves if reviewed by the Architect.
  6. A swing joint, or other required device, shall be furnished and installed in hot water lines with 10 feet of sealant or compression joint to allow for expansion.
  7. Pipe sleeves shall be provided where pipes intersect footings or foundation walls and sleeve clearances shall provide for footing settlement, but not less than one inch all around pipe.
- D. Welding of Pipe and Qualifications of Welder:
1. Joints above grade or accessible conduit or tunnels in steel piping may be either welded or screwed unless specifically indicated otherwise on Drawings or specified. Joints in below grade steel piping, whether in insulation or not, shall not be welded, unless otherwise indicated.

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2. Welded joints in pipe shall be continuous around pipe and shall comply with ASME B31: Code for Pressure Piping, unless otherwise specified.
3. Each pipe weld shall be stamped with welder's identification mark. Welding shall be performed by welders possessing a valid certificate of qualification for welding carbon steel welding pipe in horizontal position (2G) and horizontal fixed position (5G) in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code, by an Owner-recognized, DSA approved testing laboratory.
4. Before any welder performs welding on the Work, furnish the Project Inspector with a copy of welder's valid qualification papers and obtain verification. Welder qualification is not valid unless it has been issued while welder was performing work for current employer, and has performed type of work described by qualification in the preceding 3 months.
5. Welding performed under these Specifications is subject to special tests and inspections including rigid Ultra Sonic Testing (UT) and radiographic inspection at random, in accordance with Technique for Radiographic Examination of Welded Joints by an Owner recognized, DSA approved testing laboratory.

### E. Unacceptable Welds and Repairs to Welding:

1. Welds containing any of the following types of imperfections shall be deemed defective Work:
  - a. Cracks of any type.
  - b. Zones of incomplete (in excess of 1/32 inch) fusion or penetration.
  - c. Elongated slab inclusions longer than 1/4 inch.
  - d. Groups of slag inclusions in welds having an aggregate length greater than thickness of parent metal in a length 12 times the thickness of the parent metal.
  - e. Undercuts greater than 1/32 inch.
  - f. Overlaps, abrupt ridges or valleys.
2. When a defective weld is detected by examination as outlined above, two additional welds shall be radiographed at locations selected by the Project Inspector. If the two selected welds demonstrate compliant welding, then the two tested welds shall be deemed to be in compliance. Welding revealed by radiographs to be defective Work shall be removed, repaired, and tested by radiograph.

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3. If either of the two selected welds demonstrates welding deemed to be defective Work, all welding in that portion of the Work shall be deemed defective Work and either: all welds shall be cutout, prepare new ends for welding and weld to comply with this Specification, or radiograph all welds, removing and repairing only such welding deemed to be defective Work.
  4. Repair welding shall be performed in a manner in full compliance with ASME B31. The welded joints or repairs shall be spot examined with UT or radiographic tests in accordance with foregoing requirements.
  5. Owner shall cause to be performed additional random UT and radiographic examinations of welds. Owner shall be responsible for the costs of any UT and radiographic examinations found to be in compliance with specified requirements.
  6. Installer shall be responsible for the costs of UT and radiographic re-examinations of welds deemed defective Work and not in compliance with this Specification, and shall repair or replace said welds in accordance with specified requirements.
- F. Welding Rods: Submit a written list of materials and proposed type of welding rods for review by the Architect.
- G. Backing Rings: Backing rings may be submitted for installation provided the Product Data is submitted with the material list.
- H. Qualification Tests for Low-pressure Welding:
1. Tests shall be performed on 3-inch standard weight pipe ASTM A53, Grade A, and shall be welded by acetylene and electric arc. Each sample shall consist of two pieces, each 10 inches long, with 30-degree bevel at point weld.
  2. Two 20-inch samples shall be performed in the 2G and two 20-inch samples in the 5G positions, with positions defined in Section IX, ASME Boiler and Pressure Vessel Code. Welds shall have the reinforcement ground or machined flush to the surface of the pipe before testing. Samples shall be tested as full section tensile.
  3. Weld shall develop a load of 90 percent of 50,000 psi, i.e., 45,000 psi or shall develop a fracture in parent metal.
  4. Each qualified welder shall carry an identification card listing welder's name, date of test, and type of welding tests passed; signed by the welder and the laboratory.
  5. A valid certificate of qualification issued in compliance with requirements of the ASME Boiler Pressure Vessel Code Section IX shall qualify a welder for issuance of a certificate for low-pressure pipe welding.

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### I. Certificates of Qualification for Welding of Unfired Pressure Vessels:

1. Certificates of qualification shall be issued by a laboratory recognized by the Owner in compliance with the requirements of the ASME Boiler Pressure Vessel Code Section IX. Qualifications shall be for both acetylene and arc welding of Schedule 40 ASTM A53, Type B, steel welded or seamless pipe in the Horizontal Position (2G) and the Horizontal Fixed Position (5G) as defined by said code.

NOTE: Certificate described above is not valid unless it has been issued while welder was working for his current employer, and unless welder has performed type of work described by certificate in the preceding three months. Requirements for possession of a valid certificate shall not be waived for welders fabricating unfired pressure vessels when the Specifications require compliance with ASME code or when welding pipe carries working pressures greater than 75 psi and temperatures greater than 250 degrees F.

### J. Pipe Joints and Connections:

1. Pipe and tubing shall be cut per IAPMO Installation Standards. Pipe shall have rough edges or burrs removed so that a smooth and unobstructed flow shall be provided.
2. Threaded Pipe: Joints in piping shall be installed according to the following service schedule:
  - a. Refrigerant and Soap Piping: Litharge and glycerine, or Expando, Gasoila, or equal.
  - b. All other services Furnish sealant, suitable and as reviewed by the Architect.
3. Threads on pipe shall be cut with sharp, clean, unblemished dies and shall conform to ANSI/ASME B1.20.1 for tapered pipe threads.
4. Joint compounds shall be smoothly placed on male thread and not in fittings. Threaded joints shall be installed tight with tongs or wrenches and sealant of any kind is not permitted. Failed joints shall be replaced with new materials. Installation of thread cement or sealant to repair a leaking joint is not permitted.
5. Sharp-toothed Stillson, or similar wrenches, is not permitted for the installation of brass pipe or other piping with similar finished surfaces.

### K. Copper Tubing and Brass Pipe with Threadless Fittings:

1. Silver brazed joints shall be used for attaching fittings to non-ferrous metallic refrigerant piping.
2. Non-pressure gravity fed condensate lines may be soldered with 95/5 solder.

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3. Silver brazing alloy, Class BCUP-5. Surfaces to be joined shall be free of oil, grease, and oxides. Socket of fitting and end of pipe shall be thoroughly cleaned with emery cloth and wiped to remove oxides. After cleaning and before assembly or heating, flux shall be installed to each joint surface and spread evenly. Heat shall be applied in accordance with instructions in the Copper Tube Handbook issued by Copper Development Associates. Joints constructed of rough bronze fittings shall be provided as recommended by manufacturer.
  4. Do not overheat piping and fittings when installing silver brazing.
  5. Joints in non-ferrous piping for services not covered above shall be installed with solder composed of 95/5 tin/antimony, ASTM B32, Grade 5A. Surfaces to be jointed shall be free of oil, grease, and oxides. Sockets of fitting and end of pipe shall be thoroughly cleaned with emery cloth to remove oxides. Solder flux shall be sparingly installed and solder added until joint is completely filled. Do not overheat. Excess solder, while plastic, shall be removed with a small brush in order to provide an uninterrupted fillet completely around joint. Random inspection of joints shall be conducted by Project Inspector to ensure joints are lead-free.
  6. Grooved end joints for copper piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.
- L. Ring-Type Pipe: Joints shall be installed in accordance with manufacturer's instructions with grooved couplings, fittings and rubber rings. Couplings and pipe shall be compatible and of the same manufacturer. Rings shall be accurately located and installed by grooves in coupling. Pipe shall be installed with zero deflection unless otherwise specified. Pressure pipe shall be furnished with thrust blocks at each offset point.
- M. Welded Pipe Joints:
1. Joints in welded steel pipelines shall be installed by oxyacetylene or electric arc process. Welding shall be continuous around pipe and provided as specified.
  2. Butt welds shall be of the single V-type, with ends of pipe and fittings beveled approximately 37 ½ degrees. Piping shall be aligned before welding is started with the alignment maintained during welding.
  3. Welds for flanges and socket fittings shall be of the fillet type with a throat dimension not less than pipe wall thickness.
- N. Grooved End Pipe Joints: Grooved end joints for carbon steel piping shall be assembled in accordance with the latest manufacturer recommendations. Pipe ends

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shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. Grooving tools shall be as manufactured by Victaulic, RIDGID, MAG Tool, or equal.

- O. Joints shall be Vic-Press 304TM, or equal, made with Victaulic Series 'PFT' tools and the appropriate sized jaw. Pipe shall be certified for use with Vic-Press 304TM system, and shall be square cut, properly deburred and cleaned, and marked at the required location to insure full insertion into the fittings and/or couplings.
- P. Valves: Valves shall conform to the following:
  - 1. Piping systems shall be furnished with valves at points indicated on Drawings and specified, arranged to provide complete regulating control of piping system throughout building and the Project site.
  - 2. Valves shall be installed in a neat grouping, so that parts are easily accessible and maintained.
  - 3. Pressure Independent Characterized Control valve type shall be suitable for service on which installed.
  - 4. Valves shall be full size of line in which they are installed, unless otherwise indicated on Drawings or otherwise specified, and shall be one of types specified.
  - 5. Provide chain operators on valves 2-inch and larger located 7 feet or more above the servicing floor level.
  - 6. Valves for similar service shall be of one manufacturer.
  - 7. Except where otherwise specified, valves shall be Belimo, Victaulic, Stockham, Crane, Jenkins, Milwaukee, Hammond, American Valve, NIBCO, Hoffman, or equal.
  - 8. Ball valves below grade in yard boxes shall have stainless steel handles.
  - 9. Temperature relief valves and combination temperature and pressure relief valves shall be as specified and furnished as set forth in this Section. Discharge pipe from relief valves shall be not less than discharge area of valve or valves it connects, based on discharge area of valves, and shall terminate as indicated and free of any traps. Valves shall be installed at following locations:
    - a. A combination temperature and pressure relief valve or combination of valves on each heating hot water boiler. Temperature sending element shall extend into water inside boiler.
  - 10. Manual air vent valve assemblies shall be installed at each high point of hot water space heating and chilled water piping systems. Valves shall

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discharge through 1/4 inch diameter copper tubing and drain to nearest floor sink. Automatic type air vent valve shall only be installed where specifically indicated. Radiator, convectors, and finned pipe convectors shall be fitted with packless radiator valves, angle or straight pattern. Each convector or radiator installed as part of a space hot water heating system shall be furnished with a manual-type air vent valve.

Q. Strainers: Strainers shall be installed on each water main (except for fire line) downstream of the meter, above grade, when a pressure regulator assembly is not installed. Main strainer shall be of Y-flange or groove type. On closed loop chilled and heating hot water systems pump systems, a strainer shall be installed at each pump inlet and upstream of each flow control valve assembly. The control valve assembly may include a modulating temperature control valve and a flow-limiting valve, manufactured by Griswold, AutoFlow, Flow Control Industries, Inc., or equal.

R. Hangers and Supports:

1. Piping shall be securely fastened to building structure by approved iron hangers, supports, guides, anchors, and sway braces to maintain pipe alignment to prevent sagging and to prevent noise or excessive strain on piping due to uncontrolled or seismic movement under operating conditions. Hangers and supports shall conform to Manufacturer's Standardization Society Specification SP-69. Hangers shall be relocated as required to correct unsatisfactory conditions that may become evident when system is placed into operation. Appliances, heat exchangers, storage tanks, and similar equipment shall be securely fastened to structure in accordance with seismic requirements. Outdoor metal hangers and supports shall be hot-dipped galvanized steel, unless otherwise specified.
2. Piping shall not be supported by wire, rope, wood, plumbers' tape, or other non-recognized devices.
3. Hangers and supports shall be designed to support weight of pipe, fittings, weight of fluid and weight of pipe insulation, and shall have a minimum factor of safety of 5, based on ultimate tensile strength of material installed.
4. Burning or welding of any structural member under load is not permitted. Field welding not specified on Drawings or reviewed Shop Drawings is not permitted without review by Architect and DSA.
5. Burning holes in beam flanges or other structural members is not permitted without review by the Architect and DSA.
6. Pipe hangers on piping covered with low temperature insulation shall be installed on outside of insulation and not in contact with pipe unless otherwise detailed on Drawings. Insulation shall be protected by 18 gage galvanized steel shield, with a minimum length of 10 inches, installed completely around pipe covering between covering and hanger. Installing hangers directly on pipe and butting adjoining sections of insulation against

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hanger is permitted provided void and hanger rod are properly insulated and sealed so that no sweating occurs at hangers.

7. Hanger rods shall be fastened to structural steel members with suitable beam clamps. Clamps shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
  - a. Tolco I beam, Fig.62 for maximum 1000 lbs.
  - b. Tolco I or WF beam, Fig. 329, for maximum of 1290 lbs.
8. Hanger rods shall be fastened to concrete inserts in concrete slabs or beams. Inserts shall be Tolco, Carpenter & Patterson, Fee and Mason, or equal, as follows:
  - a. Tolco Fig.310 for maximum of 600 lbs.
  - b. Tolco Fig. 309 for maximum of 1140 lbs.
9. For fastening to wood ceilings, beams, or joists, furnish Anvil Fig. 128R, Anvil Fig. 153, Tolco 78, or equal pipe hanger flange fastened with drive screws. Under wood floors, 3/8 inch hanger rods shall be hung from 2-inch by 2-inch by 1/4 inch angle clips 3-inch long, with two staggered 10d nails, clinched over joist.
10. Hanger rod sizes for copper, iron, or steel pipe: 3/8 inch for pipe sizes 1/2 inch through 2-inch, 1/2 inch for pipe sizes 3-inch, 4-inch and 5-inch, 5/8 inch for pipe size 6-inch, and 3/4 inch for 8-inch and 10-inch pipe.
11. Turnbuckles, if furnished, shall provide a load carrying capacity equal to that of the pipe hanger with which they are being installed.
12. Pipe hangers shall be of same size, or nearest larger manufactured size available, as pipe or tubing on which they are being installed.
13. Hangers, clamps, and guides furnished for support of non-metallic pipe shall be padded with 1/8 inch thick rubber, neoprene, or soft resilient cloth.
14. Where special pipe-supporting requirements in the Specifications conflict with any standard requirements specified herein, the Specification requirements shall govern.
15. Vertical Piping:
  - a. Vertical pipe risers shall be securely supported with riser clamps of recognized type. Risers in reinforced concrete buildings shall be furnished with extension clamps fastened to pipe above each concrete floor slab with extended arms of clamp to rest on slab. Clamps shall be provided with lead or Teflon liners when installed

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on copper tubing. Clamps shall be plastic-coated when installed on non-ferrous pipe or tubing.

- b. Copper tubing in sizes 1 ½-inches and larger and steel pipelines passing up through building shall be supported at each floor of building or every 15 feet whichever is less.
- c. Copper tubing sizes 1 ¼-inch and smaller shall be supported at not intervals not more than 6 feet on center. Special provisions shall be installed for vertical lines subject to expansion and contraction caused by operating temperature differences.
- d. Vertical cast iron pipelines shall be supported from each floor and at its base. Malleable iron or steel pipe clamps with minimum thickness of 1/4 inch shall be furnished and fastened around pipe for support.

16. Horizontal Piping:

- a. Roof Mounted Piping: Pressure and non-pressure piping shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Block, or equal. Roller type supports shall be provided below and above pipe to prevent its dislodgement. Bottom of pipes shall clear the roof surface by 10 inches.
  - 1) At PVC roofing provide walk tread, polyester reinforced, UV resistant, with surface embossment at rooftop supports. Heat welding of walk pads shall only be done by manufacturer certified installers.
    - a) Sika-Sarnafil and Carlisle: Walk tread shall be no more than one inch larger than the plan area of the pipe support blocks and adhered to the roof membrane with Sika 1A or Carlisle Universal Single-Ply sealant, as applicable.
    - b) Johns Manville: Walk tread shall be installed under the pipe support blocks and adhered to the blocks, if possible, and left loose laid on top of the PVC roof system. Walk-pad shall have a minimum of 4 inches of material past perimeter on all 4 sides of block.
  - 2) Built-up roofing: Provide APP granulated modified torch-down at each pipe support block. Torch-down shall extend 2 to 4 inches beyond the edges of the block and adhered by torch application over existing cap sheet membrane. This work shall be performed by a certified roofer.

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- b. Piping Mounted to Underside of Roof and Decks and from Structure:
  - 1. Insulated steam and space heating hot water supply and return piping shall be supported with Tolco Figure 4, B-Line Figure B3140, Anvil Figure 212, or equal, steel hangers with welded eye rods to permit hinge movement at point of attachment of hangers. Hinge movement at point of support shall be provided by welded eye linked rods Tolco Figure 101L, B-Line Figure B3211X, Anvil Figure 278X, or equal.
  - 2. Chilled water supply and return piping, condenser water piping, insulated refrigerant piping may be supported with Tolco Figure 1, B-Line Figure B3100, Anvil Figure 260, or equal, hangers with rods, turnbuckles and inserts suitable for above hangers.
- c. Maximum hanger and support spacing shall conform to CPC schedule for horizontal piping installed above grade.
- 17. A hanger or support shall be installed close to the point of change in direction of a pipe run, in either a horizontal or vertical plane.
- 18. When practicable, supports and hangers for cast iron soil pipe shall be installed as close as possible to joints and when hangers or supports are not located within one foot of a branch line fitting, an additional hanger or support shall be installed at fitting.
- 19. In systems where grooved piping is used, couplings shall be provided with angle pattern bolt pads to comply with support and hanging requirements of ANSI/ASME B31.1, ANSI/ASME B31.9, and NFPA Pamphlet 13.
- S. Flashings:
  - 1. Each pipe, duct, or gas-fired equipment vent passing through roof shall be installed with waterproof flashing.
  - 2. Flashing or flanges on pipes, vents, and ducts passing through a tile or slate roof shall be constructed of sheet lead. Flashing for pipes and heater vents passing through a roof shall be 4 pound soft sheet lead. Flashing and flanges for ducts and heater vents passing through exterior walls shall be 22 gage sheet metal. Flanges and flashing shall be installed waterproof at point of connection with pipe or duct. No soldered joints on roof flashings will be allowed.
  - 3. Lead flashing and flanges shall be constructed of 4 pound sheet lead with burned joints. Flange of lead flashing or lead flange on a duct shall extend out onto roof a minimum of 12 inches from pipe or duct. Lead flashing shall extend up the pipe or duct not less than 7 inches.

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4. Sheet metal flashing shall be constructed of 24 gage galvanized sheet steel. Flanges on these flashings shall extend out onto roof a minimum of 10 inches from pipe or duct. Flanges on ducts through exterior walls shall extend out from duct a minimum of 2 ½ inches. Flanges on gas-fired equipment single-wall vents shall be of ventilated type. Type B gas vents through a roof shall be furnished with non-ventilated flashing as per NFPA Pamphlet 211.
  5. Cast iron, steel, brass, and copper pipe, which terminate less than 18 inches above roof, shall be furnished with a combination counter-flashing and vandal-proof hood for protection against water, birds and foreign matter. Cast iron, steel, brass and copper pipe, which does not terminate within 18 inches of roof, shall be furnished with a counter-flashing sleeve. Pipe, which terminates more than 18 inches above roof, shall be furnished with protection against entrance of water, birds, and foreign matter.
  6. Counter-flashing and combination counter-flashing sleeves and vandal-proof hoods shall be cast iron, vandal-proof, threaded, sealed or approved gas-heated sleeve type. Counter-flashing sleeves on each of these items shall extend down over flashing a minimum of 3/4 inch.
  7. Flashing and flanges on ducts shall be installed waterproof at point of connection to the duct by riveting and soldering. Storm collars shall be securely screwed and installed waterproof around appliance vent pipe immediately above flashing.
  8. Vent piping above roof shall be furnished with a combination counter-flashing sleeve and vandal-proof hood.
- T. Equipment Installation: Install roof or floor mounted equipment on level platforms, housekeeping pads or curbs and provide sound, vibration and seismic control measures per Section 23 0548, unless indicated otherwise whether indicated on drawings or not.

END OF SECTION



## SECTION 23 0548 - HVAC SOUND, VIBRATION AND SEISMIC CONTROL

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Reduction or elimination of excessive noise or vibration within building due to operation of equipment, machinery, piping, and ductwork as specified.
  - 1. Vibration isolators.
  - 2. Seismic restraint devices.
  - 3. Duct silencers.
  - 4. Acoustic housings.
  - 5. Lining and enclosing ductwork.
  - 6. Acoustic louvers.
  - 7. Sound attenuation boots at supply, return, exhaust and transfer air inlets, outlets and openings.
  - 8. Flexible ducts, conduits and piping.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 01 4525: Testing, Adjusting, and Balancing for HVAC.
  - 3. Section 23 0500: Common Work Results for HVAC.
  - 4. Section 23 0513: Basic HVAC Materials and Methods.
  - 5. Section 23 2013: HVAC Piping.
  - 6. Section 23 3000: Air Distribution.
  - 7. Section 23 3813: Kitchen Ventilation System.
  - 8. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
  - 9. Section 23 6418: Oil Free Centrifugal Water Chillers.
  - 10. Section 23 6423: Scroll Water Chillers.
  - 11. Section 23 6426: Rotary-Screw Water Chillers.
  - 12. Section 23 6428: Air-Cooled Rotary Screw Chillers.
  - 13. Section 23 6500: Cooling Towers.
  - 14. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

#### 1.02 GENERAL REQUIREMENTS

- A. Provide vibration isolators to eliminate or reduce the transmission of vibration noise to any part of building and mitigate vibration frequency and load imposed by equipment. Vibration isolators, base frames, inertia bases and seismic restraints shall be of sufficient size, flexibility and load distribution configuration to assure that deflection, stability and seismic restraint requirements are met without permitting excessive movement when starting. For typical units, no fewer than four isolators shall be provided. Isolators shall be provided to deflect uniformly under operating gravity and equipment thrust loadings to within plus or minus 10 percent of specified deflection values.
- B. Static deflections specified are based on the anticipated equipment characteristics. In the event the equipment proposed by the Contractor has characteristics other than those indicated, particularly the rated rpm, the static deflection shall be re-evaluated and the proper mountings and other devices shall be provided.
- C. Where fabricated vibration isolator units are indicated, furnish manufacturer's standard catalog products with printed loading ratings or certified submittals

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**D. Seismic Requirements:**

1. Refer to Seismic Restraint Manual: Guidelines for Mechanical Systems, published by SMACNA and approved by DSA, for minimum seismic restraints required on mechanical components design and construction details.
2. Provide seismic restraints for mechanical equipment or components specified. Where equipment is specified with proprietary names, design for seismic restraints is for first proprietary name listed.
3. Provide restraints, bracing and anchorage as required for the mechanical equipment, electrical equipment and components specified in the Contract Documents. Restraints, bracing and anchorage shall be installed to resist the total design earthquake or wind loads in any direction in accordance with CBC and SMACNA guidelines.
4. Provide restraints, bracing, and anchorage for the mechanical equipment and components.
5. For rigidly mounted liquid filled steel pipe, comply with the following:
  - a. Provisions of NFPA Pamphlet 13, section for sway bracing.
  - b. Provisions of NFPA Pamphlet 13, section for earthquake protection.
  - c. Hanger spacing as specified in Section 23 0513 under Hanger Spacing Schedule.
  - d. SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems and approval by DSA.
6. For flexibly mounted liquid filled steel pipe, comply with the following:
  - a. Provisions of the California Building Code for flexibly mounted equipment.
  - b. Provisions of VISCMA (Vibration Isolation and Seismic Control Manufacturer's Association) Seismic Control Device Installation, Best Practices Manuals.
  - c. Installer may provide a DSA or OSHPD approved system such as the SMACNA Seismic Restraint Manual with Addendum No. 1, the Mason Industries Seismic Restraint Guidelines or other proprietary pre-approved system.
7. For ductwork and other mechanical equipment restraints, comply with SMACNA Seismic Restraint Manual: Guidelines for Seismic Mechanical Systems and obtain approval by DSA.

**1.03 SUBMITTALS**

- A. Provide in accordance with Division 01.
1. Catalog cuts and data sheets on specific vibration isolators, seismic restraints, and anchors demonstrating compliance with the Specifications.
  2. Shop Drawings for each piece of equipment including dimensions, structural member size, support point, vibration, and seismic restraints.
  3. Written approval of frame design to be furnished by the equipment manufacturer.
  4. Drawings indicating methods for suspension, support, seismic restraints, guides, etc., for piping, ductwork, etcetera.
  5. Drawings indicating methods for isolation of pipes, ducts etcetera, piercing slabs, beams, etcetera.

- B. Vibration Test Reports: At completion of installation, submit the following documents. Submission of these documents must be complete before final acceptance of vibration isolation systems is given. Assistance from the vibration isolation equipment Manufacturer may be required.
  - 1. Complete tabulation showing for each vibration isolator:
    - a. Actual static deflection measured at the project.
    - b. Specified minimum static deflection.
  - 2. Report certifying:
    - a. Each piece of operative rotating mechanical equipment does not exceed the specified vibration displacement level.
    - b. Each piece of isolated equipment or equipment component (ducts, pipes, conduit, etcetera) is not short-circuited by any means.
    - c. Requirements of Part 2 are satisfied for equipment.

#### **1.04 QUALITY ASSURANCE**

- A. Standards and Codes: Comply with applicable codes and standards having jurisdiction including, but not limited to:
  - 1. NFPA, Pamphlet 13.
  - 2. ASHRAE Handbook: HVAC Systems and Equipment.
  - 3. SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems.
  - 4. California Building Code.
  - 5. VISCMA
    - a. Installing Seismic Restraints for Mechanical Equipment.
    - b. Installing Seismic Restraints for Duct and Pipe.
- B. Qualifications of Manufacturer and Installers: Comply with provisions as set forth in Section 23 0500: Common Work Results for HVAC.

### **PART 2 – PRODUCTS**

#### **2.01 GENERAL**

- A. Furnish and install vibration dampers, sound isolation pads, flexible connections and similar equipment required to prevent sound of water flowing in pipes, vibration of motors, and motor operated equipment from being transmitted to building structure; and, in case of fans, from being transmitted along ducts. Piping shall be isolated from vibrating equipment by furnishing required flexible connectors.
- B. Pumps and similar motor operated equipment shall be installed on anti-vibration units.
- C. Fans, except curb-mounted roof-type exhaust fans and wall mounted propeller fans, shall be installed with anti-vibration units, whether indicated on Drawings or not. Fans built into air handling units may be furnished with independent anti-vibration mountings or whole unit may be installed on an external vibration isolation system.
- D. Other equipment shall be installed on anti-vibration bases, pads, or hangers, unless specifically noted otherwise on Drawings. Package units, furnished with built in anti-vibration bases, do not require unit bases unless otherwise specified.
  - 1. Unless specified otherwise, anti-vibration bases shall be Mason Industries, M.W. Sausse & Co., the VMC Group, or equal, of the Model Number specified or indicated on the drawings. Furnished base including sub-base, shall be manufactured by same company with fan and integral motor base. Seismic restraints may be incorporated into bases or furnished separately.
  - 2. Inertia anti-vibration bases shall conform to requirements indicated.

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3. Unless noted otherwise, furnished anti-vibration bases, including supporting units for inertia bases, shall be of the spring type.
4. Selection of bases or supporting units shall be in accordance with manufacturer's recommendations based on following installed minimum effective isolation efficiencies (where not provided with each piece of equipment):
  - a. Centrifugal fans, packaged fan and coil units and cooling towers, less than 800 RPM 80 percent
  - b. Centrifugal fans over 800 RPM 90 percent
  - c. Centrifugal pumps 95 percent
  - d. Reciprocating compressors 95 percent
- E. Flexible duct connections shall be provided at inlet and outlets of each fan or HVAC unit, except curb-mounted roof exhaust fans whether indicated on the drawings or not.
- F. Flexible pipe or conduit connections shall be provided at piping and conduit connections to HVAC units, pumps, compressors and other moving (reciprocating or rotating) mechanical or electrical equipment provided under this Section whether indicated on the drawings or not.
- G. Flexible connections for Freon piping shall be seamless flexible metal hoses of type and length recommended by manufacturer and suitable for system operating pressure.
- H. Flexible connections for all other piping shall be flexible metal hose or spool type with flanged ends, unless otherwise specified. Metal hose shall be covered with protective braiding in areas where physical abrasion may occur, or for personnel safety.
- I. Spool types shall be similar to American Rubber Co., Mercer Rubber Co., PROCO Products, Inc., or equal, and hose types shall be similar to DME, Inc., U.S. Flex, Pennflex, Anaconda Flexpipe, Keflex, or equal with any required modifications to meet specified requirements. Flanges shall be furnished with steel retaining rings. Units installed on discharge side of pumps shall be furnished for a suitable working pressure of not less than 100 psig, and those on suction side for working pressures of 50 psig or 30 inches Hg vacuum.
- J. Units installed in cold water lines (less than 125 degrees F) shall furnish a minimum temperature rating of 180 degrees F and those installed in hot water lines (above 125 degrees F) shall be constructed of special heat resistant materials and be furnished for a minimum temperature rating of 220 degrees F, continuous operation. Units shall be able to withstand a maximum lateral deflection of 3/8 inch. Temperature and pressure ratings shall be molded into body of each spool unit so they are easily identified. Spool types shall be for straight in flow only.
- K. Spool type units shall be furnished with control units comprised of a minimum of two tie-rods and anchor plates or internal guide sleeves to prevent excessive elongation or misalignment. Rubber washers shall be provided under bolt heads and rubber grommets in bolt holes to prevent any metal to metal contact between bolts and flanges.
- L. Where hose type units are furnished, restraining anchors or braces shall be provided if excessive or undesirable pipe movement occurs when system is operated.

## **2.02 GENERAL PROPERTIES OF VIBRATION ISOLATORS**

- A. Shall be provided with markings so that, after adjustment, when carrying their load, deflection under load can be verified; thus determining that load is within proper range

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of device and that correct degree of vibration isolation is being provided according to the design.

- B. Isolators to operate in direct proportion to their load versus deflection curve. Load versus deflection curves shall be furnished by manufacturer and must be linear over a deflection range of 50 percent above design deflection.
- C. Wave motion through isolator shall be reduced to following extent: Isolation above resonant frequency shall follow theoretical prediction based upon an un-dampened single degree of freedom system with a minimum isolation of 50 decibels above 150 cycles per second.
- D. Vibration isolator spring diameters shall be no less than their deflected height. Furnish spring with a 50 percent overload safety factor.
- E. Unless otherwise indicated, equipment installed on vibration bases shall provide a minimum operating clearance of one inch between structural steel base and floor or support base. Provide flexible connectors in piping and flexible conduit in power wiring to minimize transmission of vibration.
- F. Isolators and springs exposed to weather shall be hot-dipped galvanized or powder coated after fabrication and before installation. Hot-dipped zinc coating shall be not less than two ounces per square foot by weight complying with ASTM A123. In addition, provide limit stops to resist wind velocity.
- G. Where indicated, provide structural steel bases with height saving brackets, and minimum of three points of support. Isolators shall be furnished with a method for leveling.
- H. Design isolators and seismic restraints for positive anchorage against uplift and overturning.
- I. Provide and install, under this Section of the Specifications, structural steel required to properly support equipment and steel required to support horizontal thrust arrestors.

**2.03 ISOLATOR TYPES**

- A. Type A: Steel Spring Isolators: Un-housed steel spring isolators, laterally stable and unrestrained. Design springs so that ratio of horizontal to vertical spring (stiffness) constant is between 0.9 and 1.3. Natural frequency of isolator must be 1/3 to 1/4 of driving frequency that is to be controlled. Isolators to provide a minimum additional travel to solid equal to 50 percent of rated deflection. Isolators shall be furnished with built-in leveling bolts complete with sound isolation pads type B. Static deflection as specified.
- B. Type B: Sound Isolation Pad: Provide under each spring isolator a sound isolation pad, utilizing high quality durable neoprene pad material, loaded to 40 psi. Build sound pad up to 2 layers of 1/4 inch thick neoprene material; separate layers with a 16 gage galvanized sheet metal plate. Top layer shall provide a hardness of 40 durometers and the bottom layer shall be 40 durometers. Cold bond sound pads together and to isolator baseplate.
- C. Type C: Neoprene-in-Shear Isolators: Isolator shall be neoprene-in-shear type as recommended by manufacturer. Isolator shall provide a static deflection under rated load at 1/4 inch.

**2.04 EQUIPMENT FRAMES**

- A. Provide mounting frames and brackets to carry load of equipment without causing mechanical distortion or stress to the equipment.

- B. Type A Frame: Wide flange members, rigidized structural steel frame with brackets. Maximum allowable deflection at any point on load frame relative to unloaded frame shall be 0.005 inch. Members to be constructed of wide flange beams, with a depth of not less than 1/10 of length of span between isolators. Frame shall be M.W. Sausse & Co. type RMSB-W, as basis of design, or Mason Industries, Caldyn, or equal.
- C. Type B Frame: Channel members, rigidized structural steel frame with brackets. Frame to be constructed of channel steel with section depth equal to 1/10th length of longest structural member. Frame shall be M.W. Sausse & Co. type RMSB-C, as basis of design, or Mason Industries, Caldyn, or equal.
- D. Type C Frame: Steel gusset or bracket welded or bolted directly to machine frame in order to accommodate isolator. Frame shall be M.W. Sausse & Co. type RMSG, as basis of design, or Mason Industries, Caldyn, or equal.
- E. Type D Frame: Fabricated of rectangular channel steel forms for floating foundations to be filled with concrete on the Project site. Channel depth to be a minimum of 1/12th of longest dimension, but in no case less than 6 inches. Form shall include 1/2 inch reinforcing bars installed each way in a layer 1 ½ inches above bottom and drilled steel members with sleeves mounted below holes to receive equipment anchor bolts. Weight of concrete and frame shall be two times or more than the weight of the unit it supports. Frame shall be M.W. Sausse & Co. type RMSBI, as basis of design, or Mason Industries, Caldyn, or equal.

## **2.05 MATERIALS AND CONSTRUCTION**

- A. Duct Silencers: Provide factory fabricated duct silencers of tubular or rectangular type, for low or medium velocity service, with arrangements, sizes, and capacities as indicated on the Drawings.
  - 1. Construction:
    - a. Fabricate silencers of galvanized steel with casing seams sealed or welded to be airtight at a pressure differential of 8 inches water gage between inside and outside of unit, and stiffen or brace as necessary to prevent structural failure or deformation at same condition, or audible vibration during normal operation. Outer casings of rectangular silencer modules shall be made of 22 gage galvanized steel in accordance with ASHRAE Guide of recommended construction for high-pressure rectangular ductwork. Seams shall be lock formed and mastic filled. Outer casings of tubular silencers shall be made of galvanized steel in 18 to 22 gage. Internal acoustic elements of rectangular silencers shall incorporate integral die formed entry and exit to minimize pressure drop and self-noise. Interior partitions for rectangular silencers shall be fabricated of not less than 26 gage galvanized perforated steel. Interior construction of tubular silencers shall be compatible with the outside casings.
    - b. Filler material shall comply with the following:
      - 1) Fire Safety Standards: NFPA 90A and NFPA 90B.
      - 2) Temperature: ASTM C411.
      - 3) Air velocity: ASTM C1071, UL 181.
      - 4) Fire Hazard Classification: ASTM E84, UL 723-Class 1, NFPA 255.
      - 5) Corrosion Resistance: ASTM C739, C665.

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- 6) Fungi Resistance: ASTM G21.
      - 7) Water Vapor Sorption: ASTM C1104, less than 1 percent by weight.
      - 8) Formaldehyde, Phenolic Resins or other Volatile Organic Compounds: 0 percent.
    - c. Airtight construction shall be provided by furnishing a duct sealing compound installed on the Project site. Silencers shall not fail structurally when subjected to a differential air pressure of 8 inches w.g. inside to outside of casing.
  2. Acoustic Performance: Silencer ratings shall be determined in a duct-to-reverberant room test facility, which provides for airflow in both directions through the test silencer in accordance with ASTM Standard E477. The test facility shall be accredited by the National Voluntary Laboratory Accredited Program for the ASTM E477 test standard. Data from a non-accredited laboratory is not permitted. The test set-up and procedure shall eliminate effects due to end reflection, directivity, flanking transmission, standing waves, and test chamber sound absorption. Acoustic ratings shall include dynamic insertion loss (DIL) and self-noise (SN) power levels both for forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions). Data shall be for test silencers no smaller than the following cross-sections:  
Rectangular, inches - 24 by 24, 24 by 30, or 24 by 36  
Tubular, inches - 12, 24, 36, and 48
    - a. Noise reduction values (dynamic insertion loss) in decibels reference 10-12 watts, shall not be less than (of the model, size and length) indicated on Drawings.
    - b. Self generated noise in decibels reference 10 to 12 watts, shall not be more than of the model, size and length indicated on Drawings.
  3. Aerodynamic performance: Airflow measurements shall be performed in accordance with ASTM specification E477 and applicable portions of ASME, Air Movement and Control Association (AMCA), and Air Diffusion Council (ADC) airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented. Air pressure drops shall not exceed those (of the model, size and length) indicated on Drawings.
  4. Certification: With submittals, provide certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance for reverse and forward flow test conditions. Test data shall be for a standard product. Rating tests shall be conducted in the same facility, shall utilize the same silencer, and shall be open to inspection if required by the Architect.
  5. Rectangular silencers shall be Industrial Acoustics Company of the model number indicated on the drawing, as basis of design, or Vibro-Acoustics, Dynasonics, SEMCO Silentair, TranSonics, Inc., or equal.
- B. Duct Liner: As indicated in Section 23 0700: HVAC Insulation.
- C. Flexible Ducts: As indicated in Section 23 0700: HVAC Insulation.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

#### **HVAC Sound, Vibration and Seismic Control - 230548**

## City of Sierra Madre Library Expansion

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- A. Provide isolators, flexible pipe connectors, flexible electrical conduit and flexible duct connectors at all moving mechanical system components to prevent transmission of vibration noise to any part of building whether indicated on the drawings or not.
- B. Install isolators to suit imposed load and the vibration frequency to be absorbed. Isolator units shall furnish adequate strength and flexibility to exhibit proper resiliency under machine load and impact without permitting excessive movement when starting.
- C. Where commercial vibration isolator and seismic restraint units are specified, furnish manufacturer's standard catalog products with printed loading ratings, or provide substantiating calculations.
- D. Install vibration isolators and seismic restraints in accordance with manufacturer's printed installation instructions.
- E. Where equipment is belt driven and motor is not installed on equipment, install motor and driven equipment on unitized support, and install entire support isolators. Unitized support to be provided with adjustable slide rails sized for motor weight and frequency. Support shall be Mason Industries type WF, M.W. Sausse & Co., type RMSF, Caldyn, or equal.
- F. Do not install any equipment, piping, conduit, ductwork, etc., that makes rigid contact with building or its structural members, unless reviewed by the Architect.
  - 1. Coordinate Work with other trades to avoid rigid contact with building.
  - 2. Correct, before installation, any conflict with other Work that would result in solid contact to equipment or piping due to inadequate space.
  - 3. Obtain inspection from the Project Inspector for concealed Work before enclosure.
  - 4. Notify manufacturer before installation of vibration isolation devices so that manufacturer may instruct and demonstrate technique for proper installation.
- G. The furnishing or installation of vibration isolators must not cause any change of position or alignment of equipment, ductwork, or piping, resulting in stresses in piping or ductwork, connections, or misalignment of shafts or bearings. Equipment, piping, and ductwork shall be maintained in a rigid position during installation. Load shall not be transferred to isolator until installation is complete and under full operational load.
- H. Air Compressors, Water Chillers, Pumps, Boilers with Integral Combustion Fans and Miscellaneous Equipment, mounted on roof or raised floors: Install each unit with its motor on a vibration isolated base utilizing type B frames, except where a type D frame is indicated on Drawings. Install steel support frame furnished by equipment manufacturer, utilizing equipment anchor bolt templates and isolator height saving brackets. Provide springs as specified for type "A" isolator; static deflection shall be a minimum of 2 inches.
- I. Fans (2000 rpm or higher) Air Compressors and Miscellaneous Equipment, mounted on grade: As specified for grade mounted boilers except furnish type C isolators.
- J. Boilers mounted on grade: Install each unit on concrete housekeeping pad with sound isolation pad designed for applicable equipment loading. Unit shall be fastened to housekeeping pad to prevent any movement.
- K. Air Handling, Air Conditioning Units, Floor Mounted Fans, and Cabinet-Installed Fans: Install entire casing including filters, mixing box, fan section, coil sections, etc., on a continuous, integral, structural steel base, as indicated. Furnish type A, B, or C frames, reinforced as necessary to prevent distortion of frame. Furnish isolator type A; static deflection shall be a minimum of 1 ½ inches.

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- L. Suspended Fans and Air Conditioning Unit Fan Coils and Unit Ventilators: Suspend each integral unit from overhead structure on steel spring and elastomer hanger isolators. Support deflection under rated load of 3/8 inch. Provide spring static deflection as follows:

Fan RPM	Min. Deflection
200 – 400	3 inches
400 – 700	2 inches
Above 700	1 inches

- M. Pipe Isolation: Where indicated and as required, furnish and support each pipe from an isolator. Isolator for the first five support locations away from vibrating equipment shall have the same deflection as the equipment isolators. After that, isolators shall be a neoprene-in-shear type of size as recommended by manufacturer; except where indicated on Drawings, pipe hanger rod shall be furnished with a steel spring isolator and elastomeric element, with lower rod capable of 30 degrees total misalignment without contact on spring housing.
- N. Seismic Restraints: Floor or pad mounted equipment that do not require vibration isolators, shall be bolted to floor or other support. Floor mounted equipment with vibration isolators shall be provided with lateral and vertical restraining devices on all sides of base to restrict displacement of equipment. On all sides of suspended equipment, provide bracing for rigid supports and provide aircraft cable restraints for resiliently supported equipment.
- O. Ductwork, duct acoustical lining, manual volume dampers and flexible ducts: Do not reduce length of duct runs, duct acoustical lining, manual volume dampers and flexible ducts for economy.
- P. Installation of flexible ducts at air inlets and outlets: Do not attach flexible ducts directly to air inlets and outlets unless a straight, smooth and uniform air flow can be achieved with sufficient space to make an elbow with a radius of at least three times the diameter of the duct. If sufficient space is not available to make such an elbow, provide a rigid elbow or a lined plenum.
- Q. Placement of Air Devices: Do not relocate air devices without the Architect's approval.

### 3.02 EXAMINATION

- A. Arrange for the services of a certified representative of isolation manufacturer to visit the Project site for inspecting installation of devices. In the event the isolators do not meet specified requirements perform necessary revisions. Submit a written report to the Architect, signed by above representative, indicating all devices are properly installed and are operating as specified or required by isolation manufacturer.

**END OF SECTION**

## SECTION 23 0553 - HVAC IDENTIFICATION

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Marking and identification required on mechanical piping systems, ducts, controls, valves, apparatus, etcetera.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 23 0513: Basic HVAC Materials and Methods.
  - 3. Section 23 0900: HVAC Instrumentation and Controls.
  - 4. Section 23 2013: HVAC Piping.
  - 5. Section 23 3000: Air Distribution.
  - 6. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
  - 7. Section 23 6418: Oil Free Centrifugal Water Chillers.
  - 8. Section 23 6423: Scroll Water Chillers.
  - 9. Section 23 6426: Rotary-Screw Chillers.
  - 10. Section 23 6428: Air-Cooled Rotary Screw Chillers.
  - 11. Section 23 6500: Cooling Towers.
  - 12. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

#### 1.02 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
- B. Submit product data and installation instructions for each item specified.
- C. Submit Samples of materials.

#### 1.03 QUALITY ASSURANCE

- A. Comply with provisions of:
  - 1. Section 23 0500: Common Work Results for HVAC.
  - 2. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.
  - 3. APWA: Uniform Color Code.Or
  - 4. IAPMO: Uniform Plumbing Code (UPC).

### PART 2 – PRODUCTS

#### 2.01 MATERIALS

- A. General: Piping systems, controls, valves, apparatus, etc., except those that are installed in inaccessible locations in partitions, walls, and floors, shall be permanently identified.

#### 2.02 VALVES

- A. Furnish prepared chart or diagram for each piping system, indicating by identifying letter or model number of each valve in the system, its location, and function.
- B. Install charts in aluminum frame with clear glass front and secure on wall where designated by the Project Inspector.
- C. Bind copies of each chart in operating instructions manual.
- D. Provide each valve with a brass, aluminum, or plastic disc, not less than 1-1/4 inches diameter bearing engraved numbers corresponding to those indicated on chart. Fasten discs to valve with No. 14 brass wire.

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- E. Provide an additional tag for safety valves and other valves that could be hazardous to safety and health of occupants. Distinguish these tags from regular valve tags by color (such as yellow with black letters, and marked "Danger"); submit Sample tag to the Architect for review.

## 2.03 INSTRUMENTS AND CONTROLS

- A. Identify panel-mounted instruments and controls with engraved bakelite nameplates permanently affixed to panel boards.
- B. Identify alarm indicating devices and alarm reset devices by nameplates.
- C. Identify damper motors and automatic valves, flow switches, pressure switches, etc., with embossed aluminum or plastic tape affixed to controller, indicating service and setting.

## 2.04 EQUIPMENT

- A. Identify each major piece of equipment with engraved bakelite nameplates permanently affixed to the equipment, indicating the room numbers it services. Equipment identification designation shall be the same to its designation indicated on the "As-Built Drawings". Room numbers in the nameplates shall correspond to the final room numbers.

## 2.05 ABOVE GRADE PIPE IDENTIFICATION

- A. Identify pipes by means of colored labels with directional flow arrows and identification of the pipe content, in conformance to ANSI/ASME A13.1 or the UPC.
- B. Materials: Precoiled acrylic plastic with clear polyester coating, all-temperature, self-adhering, as manufactured by Brady, Brimar Industries, Seton, Stranco, Inc., or equal.
- C. Size:

Outside Diameter of Pipe or Insulation	Length of Color Field	Size of Letter
$\frac{3}{4}$ to 1 $\frac{1}{4}$ -inch	8-inch	$\frac{1}{2}$ -inch
1 $\frac{1}{2}$ to 2-inch	8-inch	$\frac{3}{4}$ -inch
2 $\frac{1}{2}$ to 6-inch	12-inch	1 $\frac{1}{4}$ -inch"
8 to 10-inch	24-inch	2 $\frac{1}{2}$ -inch"
over 10-inch	32-inch	3 $\frac{1}{2}$ -inch

- D. Colors: As indicated in schedule.

- E. Locations:

1. On accessible piping, whether insulated or not (including mechanical rooms, attic and ceiling spaces); except that labels shall be omitted from piping where contained material is obvious due to its connection to fixtures (such as faucets, water closets, etc.).
2. Near each valve and branch connection in such accessible piping.
3. At each pipe passage through wall or floor.
4. At not more than 20 feet spacing on straight pipe run between bands required in 2 and 3 above.
5. At each change in direction.

- F. Application: Install on clean surfaces free of dust, grease, oil, or any material that will prevent proper adhesion. Replace non-adhering or curling labels with new labels, as required by the Project Inspector.

- G. Schedule:

Content of Pipe	Legend	Background Color	Lettering Color
Steam	Steam	Yellow	Black
Steam condensate	Stm. Cond.	Yellow	Black
Chilled water supply	Chill water supply	Green	White
Chilled water return	Chill water return	Green	White
Instrument air	Inst. Air	Green	White
Heating hot water supply	Heating hot water supply	Yellow	Black
Heating hot water return	Heating hot water return	Yellow	Black
Air conditioning condensation drain	A/C condensate drain	Green	White

## **2.06 UNDERGROUND PIPE**

- A. Detectable Marking Tape:

1. Provide and install detectable marking tape along buried piping. Tape shall be specifically manufactured for marking and locating underground utilities with electronic equipment. Tape shall be acid and alkali resistant, and manufactured with integral wires or foil backing, encased with protective cladding. Tape shall be a minimum of two inches in width.
2. Manufacturer: Reef Industries, Inc., Advantage Brands, Inc., Northtown Company, Mutual Industries, Inc., or equal.
3. Detectable marking tape shall be color-coded per APWA Color Code:
  - a. Yellow: Steam.
  - b. Blue: Water.
  - c. Red: Electric power lines, cables, conduit and lighting cables. By Division 26.
  - d. Orange: Communication, alarm or signal cables. By Divisions 26 and 27.

- B. Tracer Wire:

1. Solid copper wire type THWN, 12 AWG gage, with heat and moisture resistant insulation.

## **2.07 IDENTIFICATION OF AIR CONDITIONING EQUIPMENT**

- A. Provide identification markers to locate air conditioning equipment above T-bar ceilings. Install 3/4 inch to one inch diameter colored self-adhesive dots to T-bar ceiling grid indicating point of access. The following identification markers shall be recorded on the project record documents:

1. Fire Damper and Combination Fire/Smoke Fire Damper: Red.
2. Manual Volume Dampers, Relief Dampers, Motorized Volume Dampers: Blue.
  - a. Supply air: Full dot.
  - b. Return air: Half dot.

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3. Fan coil unit: Green.
4. Filter Location if separate from fan coil: Yellow.

**PART 3 – EXECUTION**

**3.01 INSTALLATION**

- A. Correct detrimental conditions prior to commencing the Work of this Section. Install markers and identification tags as specified with materials and installation procedures recommended by manufacturer.
- B. Place tracer wire on top of non-metal utility lines allowing some slack. Do not wrap tracer wire around pipe. Fasten tracer wire in place at approximately 10 feet on centers with non-metal ties.
- C. Install underground detectable pipe marking tape continuously buried 8 to 10 inches above the buried utility pipe. Wrap tape on pipe risers up to a height of 12 inches above grade.

**3.02 CLEANUP**

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

**END OF SECTION**

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## SECTION 23 0700 - HVAC INSULATION

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Condensate drain piping from air conditioning equipment.
  - 2. Vacuum and condensate pump discharge lines over 50 feet in length.
  - 3. High and low temperature equipment.
  - 4. Heating hot water supply and return piping.
  - 5. Chilled water supply and return piping.
  - 6. Refrigerant piping.
  - 7. Supply and return air ducts for heating and cooling systems air ducts.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 23 0500: Common Work Results for HVAC.
  - 3. Section 23 0513: Basic HVAC Materials and Methods.
  - 4. Section 23 0553: Mechanical Identification.
  - 5. Section 23 2013: HVAC Piping.
  - 6. Section 23 2016: Underground HVAC Piping.
  - 7. Section 23 3000: Air Distribution.
  - 8. Section 23 5000: Central Heating Equipment.
  - 9. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

#### 1.02 REFERENCES

- A. American Society for Testing and Materials International (ASTM):
  - 1. ASTM C167 - Standard Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
  - 2. ASTM C209 - Standard Test Methods for Cellulosic Fiber Insulating Board.
  - 3. ASTM C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.
  - 4. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - 5. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - 6. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - 7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  - 8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
  - 9. ASTM D5116 - Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
  - 10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 11. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
  - 12. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
  - 13. ASTM G22 - Standard Practice for Determining Resistance of Plastics to Bacteria.
- B. Underwriters Laboratories Inc.:

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1. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
2. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- C. National Fire Protection Association:
  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 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

### 1.03 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
  1. Complete material list of items to be furnished and installed under this Section.
  2. Manufacturer's specifications and other data required demonstrating compliance with the specified requirements.
  3. Shop Drawings, catalog cuts and manufacturer's data indicating insulation, jacketing, adhesives, and coating. Insulating materials shall be certified by manufacturer to comply with the California quality standards for insulating materials.
  4. Display sample cutaway sections.
  5. Manufacturer's recommended method of installation procedures, which will become part of this Section.

### 1.04 QUALITY ASSURANCE

- A. Qualifications of Manufacturer and Installer, Materials, Fabrication, Execution, and Standard of Quality: Comply with provisions stated under Section 23 0500: Common Work Results for HVAC and Section 23 0513: Basic HVAC Materials and Methods.
- B. Test Ratings:
  1. Comply with provisions stated under Section 23 0500 and 23 0513 with emphasis on ASTM E84, NFPA 255, or UL 723. ASTM C167, ASTM C302, UL label or listing of satisfactory test results from the National Institute of Standards and Technology, or a satisfactory certified test report from an acceptable testing laboratory. Approval by the State Fire Marshal is required.
  2. Furnish labels, legibly printed with the name of the manufacturer or listings indicate that fire hazard ratings do not exceed those specified for materials proposed for installation. Flame spread index of not more than 25 and smoke developed rating not exceeding 50.
  3. Tests shall be performed on each item individually when insulation, vapor barrier covering, wrapping materials, or adhesives are installed separately at the Project site.
  4. Test insulation, vapor barrier covering, wrapping materials and adhesives as an assembly when they are factory composite systems.
- C. Regulatory Requirements: Insulation furnished and installed under this Section shall conform to the requirements of the California Building Code Parts 4, Mechanical Code, Part 5, Plumbing Code and Part 6, Energy Code.
- D. All chemically based products such as sealers, primers, fillers, adhesives, etc. shall meet the California air quality regulations.

### 1.05 PRODUCT HANDLING

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- A. Protection, Replacement, Delivery and Storage: Comply with provisions stated under Sections 23 0500: Common Work Results for HVAC and 23 0513: Basic HVAC Materials and Methods.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS**

- A. General:
1. Piping insulating material shall be fire resistant, non-corrosive, shall not break, settle, sag, pack or disintegrate under vibration, nor absorb more than 1 percent moisture by weight.
  2. Piping insulating material shall be furnished with thickness indicated in Table 1, unless otherwise noted on the drawings, and shall furnish thermal resistance in the range of R-4.0 to 4.6 in accordance with inch at 75 degrees F. For any other value of R, insulation thickness shall be calculated accordingly and submitted for review.
  3. Asbestos in any quantity in insulating material is not permitted.
  4. Provide insulation materials, adhesives, coatings, sealants, fitting covers, and other accessories with a fire hazard rating not to exceed 25 for flame spread, 25 for fuel contributed and 50 for smoke developed, except for materials listed as follows:
    - a. Nylon anchors for installing insulation to ducts or equipment.
    - b. Treated wood blocks.
  5. Flame-proofing treatments subject to moisture damage are not permitted.

**TABLE 1 - MINIMUM PIPING INSULATION THICKNESS (1)**

Insulation Thickness Required (in inches)

Space Heating Systems (Steam, Steam Condensate and Hot Water)

<b>Piping System Type</b>	<b>Temp. Range (degrees F)</b>	<b>Run-outs up to 2 (2)</b>	<b>1 and less</b>	<b>1.25 to 2</b>	<b>2.5 to 4</b>	<b>5 to 6</b>	<b>8 and larger</b>
Hi Pres Temp	Above 350	1.5	2.5	2.5	3.0	3.5	3.5
Med Pres Temp	251 to 305	1.5	2.0	2.5	2.5	3.5	3.5
Low Pres Temp	201 to 250	1.0	1.5	1.5	2.0	2.0	3.5
Hot Water	Up to 200	0.5	1.5	1.5	1.5	1.5	1.5
Steam Cond.	-	0.5	1.0	1.0	1.0	1.5	1.5

Service Water Heating Systems (recirculating, piping supply and return)

Hot Water	Up to 180	0.5	1.0	1.0	1.5	1.5	1.5
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Space Cooling Systems (Chilled water, Brine and Refrigerant)

Chilled Water	40-60	0.5	0.5	0.75	1.0	1.0	1.0
Refrigerant/Brine	Below 40	1.0	1.0	1.5	1.5	1.5	1.5
Condensate Drain	½-inch Minimum insulation thickness.	0.5	0.5	0.5	0.5	0.5	0.5
From Air Conditioning Equipment:	Insulate condensate drain lines within building, in room, inside walls and above ceilings.	0.5	0.5	0.5	0.5	0.5	0.5

NOTES:

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- (1) For Underground HVAC Piping refer to section 23 2016 Underground HVAC Piping.
  - (2) For piping exposed to ambient temperatures, increase thickness by 0.5 inch.
  - (3) Run-outs to individual terminal units, not exceeding 12 feet in length.
- B. Lagging Adhesives: Shall be nonflammable and fire-resistant and shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Insulation finished with canvas shall be provided with laps adhered in accordance to manufacturer's recommendation. A finish coat of same material shall be applied to entire outer surface of lagging cloth at coverage specified by manufacturer.
- C. Canvas Jackets: Furnish 6 ounce in accordance with square foot minimum, 48 by 48 thread count canvas jacketing.
- D. Insulation Jackets:
1. Exterior insulation exposed to weather shall be weatherproofed with Childers aluminum jacketing as basis of design, or Pabco, RPR, or equal. Jacketing shall be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16-inch corrugations. Smooth or embossed jackets may be permitted in special situations to match an existing installation. Jacketing shall be furnished with an integrally bonded moisture barrier over entire surface in contact with insulation. A minimum thickness of 0.016 aluminum jacketing is to be provided on ducts and piping. A minimum thickness of 0.020 shall be provided on tanks, equipment, and heat exchangers.
  2. Insulated elbows, of 90 degrees and 45 degrees, with a nominal iron pipe size of ½-inch to 8-inch shall be provided with Childers aluminum Ell-Jacs insulation covers as basis of design, or Pabco, RPR, or equal, manufactured from 1100 aluminum alloy of 0.024-inch thickness. Insulated elbows with a nominal pipe size of 10 inches to 18 inches shall be provided with Childers 4-piece aluminum Ell-Jacs as basis of design, or Pabco, RPR, or equal.
  3. Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Furnish Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company, Pabco, RPR, or equal.
- E. Adhesives: Adhesives shall be water based, UL Classified, meet the requirements of NFPA 90A and NFPA 90B, have been tested according to relevant ASTM requirements, and be acceptable to the State Fire Marshal. Name, type and method of installation shall be submitted for review.
- F. Valve and Fitting Cover: When installed in conjunction with PVC jacketing, furnish Zeston 25/50 rated polyvinyl chloride fitting covers as manufactured by Johns Manville, Knauf Insulation, Speedline, or equal.

## **2.02 SPACE HEATING PIPING SYSTEM**

- A. General: Insulate steam, steam condensate return, and hot water space heating supply and return, including valves, strainers and fittings with insulation thickness as indicated on Table 1.
- B. Materials:
1. Classes of Insulation:
    - a. Class A: Calcium silicate molded pipe insulation, suitable for service temperature up to 1200 degrees F, ASTM C533; Johns Manville Thermo-12 Gold, or equal. Fittings: diatomaceous silica thermal insulating cement.
    - b. Class B: Glass fiber molded pipe insulation suitable for service temperatures up to 850 degrees F. Pipe insulation shall be one piece,

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preformed, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, Knauf Redi-Klad 1000, Owens Corning FIBERGLAS Pipe Insulation SSL II-ASJ, or equal.

- c. Class C: Flexible open-cell melamine (foam insulation) suitable for service temperature -150 degrees F to 400 degrees F. Thermal conductivity at 75 degrees F,  $K = 0.26$ . Pipe insulation, one-piece pre-formed, laminated to heavy non-reinforced PVC jacket, with locking track, factory installed to jacket, to snap insulation and jacket onto pipe. Similar to TechLite 079 Series as manufactured by Accessible Products Co., or equal. Installation shall comply with manufacturers recommendations.
- d. Class D: Mineral fiber pipe insulation suitable for service temperatures up to 1,200 degrees F. Pipe insulation shall be one-piece, preformed up to 3 inches thickness, and provide a minimum R factor of 4.0 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be 8 pounds in accordance with cubic foot density by Roxul Techton 1200, Fibrex COREPLUS 1200, Industrial Insulation Group, LLC (IIG) MinWool-1200, or equal.

2. Locations and Class of Insulation Required:

TABLE 2 – LOCATIONS AND CLASS OF INSULATION REQUIRED

<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Boiler and Mechanical Equipment Room	A, B, C, or D
All Other Locations	A, B, C, or D

- 3. Fittings on indoor piping shall be covered with flush, hand-wrapped Class A, B, C, or D insulation, to match the adjoining pipe insulation and covered with polyvinyl chloride fitting covers: Zeston 2000 25/50 by Johns Manville, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.
- 4. Adhesive: Fibrous Adhesive to bond calcium silicate to itself and non-porous surfaces.

**2.03 COOLING PIPING SYSTEM INSULATION**

- A. General: Insulate chilled water supply and return piping and refrigerant piping.
- B. Materials:
  - 1. Classes of Insulation:
    - a. Class A: Expanded polystyrene pipe insulation, self-extinguishing type, either molded or extruded; Dow Chemical Co. STYROFOAM, ITW Insulation Systems XPS PIB, Foam-Control EPS, or equal.
    - b. Class B: Glass fiber molded pipe insulation ASTM C547. Pipe insulation shall be one piece, preformed, and provide a minimum R factor of 4 at 75 degrees F mean temperature. Insulation shall be faced with all-purpose fire-retardant vapor barrier jacket. Pipe insulation shall be Johns Manville Micro-Lok, CertainTeed Snap-On, Owens Corning FIBERGLAS SSL II-ASJ, or equal.
    - c. Class C: Expanded (foamed) urethane (polyurethane) or polyisocyanurate pipe insulation of self-extinguishing type molded or fabricated, Dyplast

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Products, LLC ISO-C1/2.0, ITW Trymer, Specialty Products & Insulation Co. Polyisocyanurate Pipe Insulation, Armacell Armalok, or equal.

- d. Class D: Foamed plastic pipe insulation, self-extinguishing type, ASTM C534 Type 1 - tubular. Pipe insulation shall be one-piece preformed, flexible tubing type and provide a maximum K factor of 0.28 at 75 degrees F mean temperature. Pipe insulation shall be Armacell Armaflex, Aeroflex Aerocel, Rubatex INSUL-TUBE 180, or equal.

2. Locations and Class of Insulation Required: For thickness required, refer to Table 1 of this Section.

**TABLE 3 – SERVICE, LOCATION AND CLASS OF INSULATION REQUIRED**

<u>SERVICE</u>	<u>LOCATION</u>	<u>CLASS OF INSULATION</u>
Condensate drains from air conditioning equipment	Indoors at all locations including above ceilings and between stud walls	D
Refrigerant suction Liquid line as required	All locations except underground	D
All other piping, except underground	All locations except underground	A, B, C

3. Adhesives:

- a. Polystyrene adhesives: Synthetic rubber and resin adhesives specifically designed to adhere extruded and expanded rigid polystyrene and urethane insulation to themselves and to other porous and non-porous substrates.
- b. Vapor barrier laps and penetrations: Furnish protective coating and lagging adhesive on butt joints of foil-faced vapor barriers, and where pins and staples puncture facings.

## **2.04 HIGH TEMPERATURE EQUIPMENT INSULATION**

### **A. General:**

1. Insulate heat exchangers, hot water storage tanks, flash tanks, boiler breechings, and similar equipment operating at elevated temperatures up to 450 degrees F or 850 degrees F with high temperature insulation, jacket and material.
2. Do not insulate condensate receivers, hot water expansion tanks, hot water pump casings, chemical feeders, and factory insulated boilers.

### **B. Materials:**

1. Equipment insulation shall be 1½-inch minimum fiberglass board or insulating blocks, or molded calcium silicate, ASTM C533-Type I, Johns Manville Thermo-12 Gold or 1000 Series Spin-Glas, Knauf Insulation Board, Owens Corning Fiberglas Series 700 or Fiberglas Insul-Quick, or equal.
2. Boiler breeching insulation shall be same as above except 2-inch thick minimum.
3. Adhesive: For calcium silicate, furnish fibrous adhesive of sodium silicate base.

## **2.05 LOW TEMPERATURE EQUIPMENT INSULATION**

### **A. General:**

1. Insulate water chillers, heat exchangers, air eliminators and similar equipment operating at reduced surface temperatures.
2. Do not insulate chilled water expansion tanks, and chemical feeders.

### **B. Materials:**

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1. Expanded polystyrene, 2-inch thick, self-extinguishing type, Dow Chemical Co.'s STYROFOAM, Owens Corning FOAMULAR, Foam-Control EPS, or equal, or 1½-inch thick expanded urethane (polyurethane) or polyisocyanurate, self-extinguishing type, Dyplast Products, LLC ISO-C1/2.0, ITW Trymer, Specialty Products & Insulation Co. Polyisocyanurate Pipe Insulation, or equal.
2. Canvas Jackets: 6 ounce in accordance with square foot minimum.
3. Vapor Barrier Laps and Penetrations: Furnish protective coating and lagging adhesive on butt joints of foil-faced vapor barriers and where pins and staples puncture facings.

**2.06 DUCTWORK AND PLENUM INSULATION**

- A. General: Insulate ductwork and plenums with not less than the amount of insulation tabulated in Table 4, unless noted otherwise on the drawings. Insulation may be omitted under the following conditions:

1. Exposed return air ductwork in conditioned space.
2. Return air ductwork between wall studs inside an interior wall.

TABLE 4 - INSULATION OF DUCTS AND PLENUM

<u>Duct Location</u>	<u>Insulation Type</u>
Exposed interior round and oval supply air ductwork located at Gyms and MPR Stages	DW-1
Exposed interior rectangular supply air ductwork located at Gyms and MPR Stages	L-1
Exterior locations of Health Units and Clinics	DW-2
Exterior locations other than Health Units and Clinics	L-2
In walls, within floor/ ceiling spaces	F-1 or L-1 See note 3
Hot and cold plenums	F-2, DW-1 or L-2 See note 3
Attics, Garages, and Crawl Spaces, within unconditioned space or in basement	F-3 or L-2 See note 3

- B. Insulation Types:

1. DW-1: 1-inch thick insulation sandwiched inside double-wall type ducts and fittings.
2. DW-2: 2-inch thick insulation sandwiched inside double-wall type ducts and fittings. Duct joints shall be waterproofed.
3. F-1: 1½-inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
4. F-2: 2-inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
5. F-3: 3-inch blanket fiberglass, factory-laminated with all-service jacket vapor barrier.
6. L-1: 1½-inch Internal duct lining.
7. L-2: 2-inch Internal duct lining.

- C. Notes:

1. Minimum insulation provided shall be as required by the current California Mechanical Code Title 24 for the most restrictive condition.
2. Refer to the materials indicated in this section for external insulation & Internal Lining.

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3. External insulation shall be replaced with internal duct lining (of equivalent thermal resistance value unless noted otherwise) where indicated on the drawings or specified elsewhere for sound attenuation.
4. Provide internal duct lining (1 ½-inch unless noted otherwise) where indicated on the drawings or specified elsewhere for sound attenuation.
5. All exterior insulated ductworks shall be water proofed at joints, seams and duct penetrations.

**D. Materials:**

1. Fire-Resistive Insulation Materials and Coatings: Submit State Fire Marshal pre-approved materials only.
2. Adhesives: See Paragraph 2.01.E for applicable products.
3. External Insulation: Provide glass fiber blankets that are factory-laminated with Foil Reinforced Kraft (FRK) vapor barrier facing; Johns Manville Microlite, Owens-Corning SOFTR Duct Wrap, Knauf Insulation Friendly Feel Duct Wrap, or equal. Provide a minimum installed R value as required by the CEC Building Energy Efficiency Standards; but not less than scheduled on Table 5:

TABLE 5  
INSULATION OF DUCTS AND PLENUM INSTALLED  
THERMAL RESISTANCE "R" VALUES

Type	Labeled Thickness (in inches)	Installed R Value (hr.ft <sup>2</sup> .°F/Btu)
F-1	1 ½	4.2
F-2	2	5.6
F-3	3	8.3
DW-1	1	4.2
DW-2	2	5.6
L1	1 ½	6.0
L2	2	8.0

4. Internal Lining: Internal Lining shall be of the type that inhibits the growth of mold, mildew and fungi and shall not contain harmful VOC's or contain glass fiber.  
Approved Material:
  - a. Polyester Duct Liner:
    - 1) Polyester duct liner shall be an engineered nonwoven, thermally bonded Polyester with a smooth and durable FSK facing.
    - 2) Polyester duct liner must be able to withstand a constant internal temperature up to 250°F must be compliant with Greenguard Environmental Institute and contain zero VOCs per ASTM D5116. Liner must comply with all applicable standards including ASTM E84, ASTM C411, ASTM C518, ASTM G21, NFPA 90A and 90B, and UL 181.
    - 3) Approved Manufacturer: Ductmate Industries "PolyArmor" duct liner or approved equal.
  - b. Elastomeric duct liner:
    - 1) Closed-cell, sponge- or expanded-rubber materials. Elastomeric liner must be able to withstand a constant internal temperature up to 300°F and must comply with all applicable standards including ASTM E84, ASTM E96, ASTM C209, ASTM C534 -

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Type II sheet materials, ASTM C411, ASTM C518, ASTM G21, ASTM G22, NFPA 90A and 90B, and UL 181.

- 2) Approved Manufacturer: Armacell LLC "AP Armaflex FS" duct liner or approved equal.
- c. Duct liner must be attached per manufacturer's requirements using a non-flammable, low VOC water-based adhesive. When applicable, apply a non-flammable, low VOC water-based lagging adhesive to the exposed leading edge of the insulation. Install fasteners per SMACNA HVAC Duct Liner installation instructions.
- d. Duct liner must be installed per SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible," Third Edition unless otherwise specified.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

- A. Except as specified herein, install material in accordance with recommendations of manufacturer. Do not install insulation materials until tests specified in other sections are completed. Remove foreign material such as rust, scale, or dirt. Surfaces shall be clean and dry. Maintain insulation clean and dry at all times.
- B. On cold surfaces where a vapor barrier must be provided and maintained, insulation shall be installed with a continuous, unbroken moisture and vapor seal. Hangers, supports, anchors, or other projections that are fastened to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. Surface finishes shall be extended in such a manner as to protect raw edges, ends, and surfaces of insulation.
- D. Pipe or duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where fire-stop or fire-safing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Inserts shall be of equal thickness to adjacent insulation and shall be vapor sealed accordingly.
- F. Insulation shall not be installed in the following locations unless otherwise noted:
  1. On vacuum return lines less than 50 feet long.
  2. On unions, flanged connections or valve handles.
  3. Over edges of any manhole, clean-out hole, clean-out plug, access door or opening to a fire damper, so as to restrict opening or identification of access.
  4. Over any label or stamp indicating make, approval, rating, inspection, or similar data, unless provision is made for identification and access to label or stamp.

#### **3.02 INSTALLATION OF HEATING PIPING SYSTEM INSULATION**

- A. General: Space heating hot water, domestic hot water, tempered water supply and return piping and condensate return piping, after having been tested, shall be cleaned and insulated.
- B. Application: Insulate condensate return piping, hot water heating supply and return piping, steam and steam condensate piping, domestic hot water supply and return, including tempered supply and return piping in accordance with manufacturer's instructions and as specified herein.

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1. Install insulation on valve bodies up to valve bonnet. Fill void in saddles, in accordance with Section 23 0513: Basic HVAC Materials and Methods, with insulation and seal joints.
  2. Install insulating material to fittings, valves, and strainers and smooth to thickness of adjacent covering. Leave strainer clean-out plugs accessible. Covers fabricated from polyvinyl chloride shall be furnished.
- C. Insulation Jackets in Exposed Indoor Locations:
1. Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams 1-1/2-inch minimum. Finish entire jacket with coating of undiluted adhesive.
  2. Equivalent factory applied pre-sized, glass fiber reinforced, or glass fiber jackets may be furnished. Seal jacket seams with adhesive in accordance with manufacturer's instructions.
  3. Johns Manville Zeston 2000, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal, fitting covers may be furnished, with molded or segmented insulation equal to specified insulation applied to fittings. Secure covers in accordance with manufacturer's instructions.
  4. In addition to above requirements, cover exposed insulated piping within a distance of 8 feet above floors with 26 gage galvanized steel jacket. Omit jacket in areas accessible only to maintenance personnel, such as mechanical equipment rooms, utility corridors, accessible pipe tunnels and manholes.
- D. Concealed Indoor Locations: Cover insulation over fittings, valves, and strainers with canvas. Provide pipe insulation with factory or field applied standard jacket of 4-ounce minimum canvas, fiberglass cloth, or glass fiber reinforced jacket. Seal jacket laps with adhesive in accordance with manufacturer's instructions.
- E. Exposed Outdoors: In addition to canvas or fiberglass cloth cover, pipe insulation exposed to weather shall be provided with an additional 0.016-inch thick aluminum jacket with 2-inches lap connected with 1-inch hem overlap joint located on side of pipe and turned down to shed water. Jacket shall be strapped 12-inch on center with 1/2-inch wide stainless-steel strapping and wing seals. Aluminum jacket shall be mitered to fit fittings.

### **3.03 INSTALLATION OF COOLING PIPING SYSTEM INSULATION**

- A. General: Chilled water supply and return piping, refrigerant piping and condensate drain lines, after having been tested, shall be cleaned and insulated.
- B. Application: Insulation on chilled water lines, refrigerant suction lines and liquid lines, if indicated, and air conditioner interior drain lines shall be jacketed with fire-resistant vapor barrier of laminated aluminum foil consisting of 2 plies with glass-yarn reinforcing. Jacket joints shall be lapped and sealed with an approved adhesive. Insulation shall be secured with aluminum bands not less than 0.005-inch thick by 3/4-inches wide, spaced not over 12-inch on centers, or as recommended by manufacturer.
1. Longitudinal Seams: Butt hinged sections of covering tightly together and seal down jacket flap with adhesive, or with factory-applied, self-sealing lap with pressure-sensitive sealer protected with release paper.
  2. End Joints: Wrap joint with a 3-inch wide (minimum) self-sealing tape.
  3. Fittings and Valves: Fittings and valves shall be covered with same material of same thickness as pipe insulation, sealed with an approved, vapor-sealing tape or compound and covered with Johns Manville Zeston polyvinyl-chloride cover, Knauf Insulation Proto PVC Fitting Cover, Speedline Polyco Smoke Safe, or equal.

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4. Pipe hangers shall be insulated or attached to pipe by an insulating insert, butted between adjoining insulation sections.
- C. Additional Jackets:
  1. Exposed Indoor Insulation: Cover with 26 gage galvanized sheet metal jacket to 8 feet above floors, except in mechanical equipment rooms and accessible pipe tunnels.
  2. Exposed Outdoor Insulation: In addition to canvas or fiberglass cloth cover, provide 0.016-inch thick aluminum jacket with 1-inch wide aluminum bands and seals. Install appropriate jackets on valves and fittings.

**3.04 INSTALLATION OF HIGH TEMPERATURE EQUIPMENT INSULATION**

- A. General: Provide insulation over parts of heat exchangers and similar equipment requiring insulation having removable head or sections.
- B. Application:
  1. Equipment: Securely tie insulation on with copper clad wire. Install tack coat weather barrier coating at a thickness specified by manufacturer. While tack coat is still wet, a layer of 10 open weave glass cloth membrane shall be embedded with fabric seams overlapped a minimum of 2-inch. Install a finish coat fully covering membrane at coverage rate specified by manufacturer.
  2. Boiler Breechings: Wire securely V-rib wire lath, ¾-inch minimum depth to boiler breechings, connections and stacks inside boiler rooms, and cover with insulation and jacket as specified above.
  3. Manholes and Hand Holes: Maintain accessible by beveling off permanent insulation around manhole and cover manhole plate with removable blanket.

**3.05 INSTALLATION OF LOW-TEMPERATURE EQUIPMENT INSULATION**

- A. General: Provide removable sections of insulation over parts of chillers and similar equipment requiring insulation and having removable heads or sections.
- B. Exterior surfaces of chilled water system expansion tanks and chilled water pumps shall be insulated with not less than 2-inch thick expanded polystyrene or fiberglass, as specified. Fill spaces between insulation and equipment with granulated polystyrene or urethane to eliminate voids. Insulation shall be secured with metal band, and covered with one inch, 20 gage hexagon galvanized mesh and ¼-inch thick insulating cement troweled smooth. Cement surface shall then be covered with 0.002-inch aluminum foil applied smoothly and secured with suitable adhesive, and a layer of 6-oz. canvas.
- C. Coat joints of polyurethane insulation with neoprene based contact adhesive. Adhesives furnished shall be approved by insulation manufacturer. Fill and seal external voids and seams with non-shrinking sealant.
- D. Canvas Jacket: Cover completed insulation with canvas jacket tightly pasted to covering with lagging adhesive. Lap jacket seams a minimum of 1 ½-inch. Finish entire surface of canvas jacket with one brush coat of diluted lagging adhesive, Childers CP-50A, Foster 30-36, Mon-Eco Industries (MEI) Eco-Lag Adhesive, or equal, and heavy final coat of undiluted adhesive.

**3.06 INSTALLATION OF DUCTWORK AND PLENUM INSULATION**

- A. External Covering:
  1. Before installing duct insulation, sheet metal ducts shall be clean, dry, and tightly sealed at joints and seams, inspected pressure tested, and accepted by District Representative/ Inspector.
  2. Duct exterior insulation shall be firmly wrapped around ductwork with joints lapped a minimum of 2-inch. Insulation shall be securely fastened with 18 gage

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copper-lined steel wire, or 16 gage soft-annealed galvanized wire spaced approximately 12-inch on centers and at loose ends, presenting a neat and workmanlike appearance. Where duct width is such that wiring will not fasten insulation firmly against duct an adhesive shall be furnished to fasten insulation to duct with wiring being installed at ends of insulation segment.

3. Insulation on ductwork transporting conditioned air, both supply and return, and outside air intake ducts when pre-conditioned, shall be furnished with a factory-applied, fire-resistant vapor barrier.

4. Exposed Ducts or Plenum:

- a. Install insulation to ducts or plenum furnished with butt joints, without voids and with adhesive over entire surface of duct. Cover insulation with canvas jacket, fastened tightly to insulation with lagging adhesive. Install 2 finish coats of undiluted adhesive.
- b. When installing jacket, finished covering shall be even and level, without humps, with constant diameters on round ducts maintained.

- B. Interior insulation - lining:

1. Dimensions of ducts indicated are net inside dimensions and must include thickness of duct liners to obtain the required duct size.
2. Install insulation in square turns, where required, to cover interior surfaces before duct turns are installed.
3. Install lining material during fabrication of duct with sealed face only exposed to air stream.
4. Interior insulation in ducts or plenums shall not have exposed edges. Edges open to entering or leaving air streams shall be covered, secured in place and sealed with approved duct liner edge sealers.
5. Insulation shall be fastened to sheet metal with an approved fire-retardant adhesive, with minimum 90 percent coverage and edges firmly adhered.
6. Mechanical fasteners shall supplement the adhesive on top sections of ducts more than 12-inch wide and on sides of ducts more than 24-inch high and shall be spaced on 16-inch centers maximum. Fastener posts shall be cut off approximately ¼-inch from metal disc.

### **3.07 CLEANUP**

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

### **3.08 PROTECTION**

- A. Protect the Work of this Section until Substantial Completion.

**END OF SECTION**

## SECTION 23 2013 ABOVE GROUND HVAC PIPING

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Above ground piping systems for heating, ventilating, and air conditioning systems. Systems include but are not limited to the following:
  - 1. Chilled Water System.
  - 2. Condenser Water.
  - 3. Hot Water Heating System.
  - 4. Low-pressure Steam.
  - 5. Miscellaneous Piping Required for Equipment of this Section.
  - 6. Connections to Exterior Utilities.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 23 0500: Common Work Results for HVAC.
  - 3. Section 23 0513: Basic HVAC Materials and Methods.
  - 4. Section 23 0548: HVAC Sound, Vibration and Seismic Control.
  - 5. Section 23 0553: HVAC Identification.
  - 6. Section 23 0700: HVAC Insulation.
  - 7. Section 23 0900: HVAC Instrumentation and Controls.
  - 8. Section 23 2016: Underground HVAC Piping.
  - 9. Section 23 2500: HVAC Water Treatment.
  - 10. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
  - 11. Section 23 6418: Oil Free Centrifugal Water Chillers.
  - 12. Section 23 6423: Scroll Water Chillers.
  - 13. Section 23 6426: Rotary-Screw Water Chillers.
  - 14. Section 23 6428: Air-Cooled Rotary Screw Chillers.
  - 15. Section 23 6500: Cooling Towers.
  - 16. Section 31 2323: Excavation and Fill for Utilities.

#### 1.02 REFERENCES

- A. ASTM International:
  - 1. ASTM A47 – Standard Specification for Ferritic Malleable Iron Castings.
  - 2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
  - 4. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 5. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
  - 6. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  - 7. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
  - 8. ASTM B32 - Standard Specification for Solder Metal.

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9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- B. American National Standard Institute (ANSI) and The American Society for Mechanical Engineers (ASME):
  1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
  2. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
  3. ANSI/ASME B16.9 - Factory Made Wrought Butt-welding Fittings.
  4. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

### 1.03 SUBMITTALS

- A. Provide submittals in accordance with Division 01, Sections 23 0500, Common Work Results for HVAC, and 23 0513, Basic HVAC Materials and Methods.
- B. Provide Shop Drawings with dimensioned piping layout and details of expansion loops, elbows, anchor points, pipe supports, building entry points and other pertinent information required to verify layout. Indicate systems, pipe material and sizes, show location of devices such as pumps, unions, joints, valves, flow measuring devices, fittings, flexible connectors, and location of hangers and supports, intent and type of materials are in accordance with this Section. Prefabricated pipe units shall be dimensioned and numbered to fit actual Work with field verified conditions prior to start of factory fabrication.
- C. Submit manufacturer's Product Data for products listed on Part 2 of this section, demonstrating conformance to specified standards and specification requirements.

### 1.04 QUALITY ASSURANCE

- A. Comply with applicable codes and referenced standards: ASTM, ASME/ANSI, CPC (California Plumbing Code), CMC (California Mechanical Code).
- B. Qualifications of Manufacturer: Products used in the Work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production.

### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.

### 1.06 COORDINATION

- A. Coordinate related and adjacent activities in accordance with Section 01 3113, Project Coordination.

## PART 2 – PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

- A. Low Pressure Steam Systems:
  1. Pipe: ASTM A53 Schedule 40 Type S-seamless Grade B black steel. Pipes and fittings shall be properly marked with schedule number, ASTM number, manufacturer, etcetera, in accordance with ASTM requirements.
  2. Fittings:

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- a. 2-inch and smaller: 150 pound standard weight, black, malleable iron, threaded. Material conforms to ASTM A47; threads, ANSI/ASME B1.20.1 malleable iron, threaded.
    - b. 2 ½-inch and larger: Standard weight, seamless steel; welding fittings and flanges ASTM A234 and ANSI/ASME B16.9 for fittings and ASTM A181 or ASTM A105 for flanges.
  3. Joints: Refer to Section 23 0513, Basic HVAC Materials and Methods, for threaded pipe joints and welded connections.
  4. Unions on piping 2-inch Diameter and Smaller: 150 pound malleable iron, ground joint pattern, brass to iron seat, ASME B16.39 or ASTM A47, grade 32510, black.
  5. Flanges on Piping 2 ½-inch Diameter and Larger:
    - a. 150 pound forged steel, weld neck or slip-on, ASTM A181 and ANSI/ASME B16.5. Furnish flat faced flanges against equipment with flat faced flanges.
    - b. Flange gaskets: Mineral fiber, 1/16 inch thick, equivalent to Garlock Style 9800, Durlon 8300, or equal.
    - c. Bolting materials: Carbon steel heavy hex bolts and nuts, ASTM A307, type B.
- B. Chilled Water, Heating Hot Water and Condenser Water:
  1. Pipe:
    - a. 2-inch and smaller: Standard weight, seamless copper, type L hard drawn, ASTM B88.
    - b. 2 ½-inches and larger: Schedule 40 seamless black steel, ASTM A53, grade B, type S. Pipes and fittings shall be properly marked with schedule number, ASTM number, manufacturer, etcetera, in accordance with ASTM requirements.
  2. Fittings:
    - a. 2-inch and smaller: Wrought solder-type copper, in accordance with ANSI/ASME B16.22.
    - b. 2 ½-inch and larger:
      - 1) 150 pound forged steel, weld neck or slip-on, ASTM A181 and ANSI/ASME B16.5. Furnish flat faced flanges against equipment with flat faced flanges.
      - 2) Flange gaskets: Mineral fiber, 1/16 inch thick, equivalent to Garlock Style 9800, Durlon 8300, or equal.
      - 3) Bolting materials: Carbon steel heavy hex bolts and nuts, ASTM A307, type B.
  3. Joints:
    - a. 2-inch and smaller: 95 percent tin and 5 percent antimony solder with non-acid flux type flux, ASTM B32, grade 95TA.
    - b. 2 ½-inch and larger: Standard weight, seamless steel; welding fittings and flanges ASTM A234 and ANSI/ASME B16.9 for fittings and ASTM A181 or ASTM A105 for flanges.
  4. Unions:
    - a. 2-inch and smaller Wrought solder type, copper to copper; furnish ground joint cast bronze low lead unions, NIBCO 733, where copper connects to steel.

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- b. 2 ½-inch and larger: Refer to Section 23 0513, Basic HVAC Materials and Methods, for threaded pipe joints and welded connections.
- C. Valves: Chilled Water and Condenser Water.
1. Ball Valves, 2-inch and Smaller: Shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.

<u>Threaded</u>	<u>Solder</u>
Stockham T-285-FB-R-70 (full port)	Stockham S-285-FB-R-70 (full port)
Crane 9301	Crane 9302
Worcester 44-11-RT-SE	Worcester 44-11-RT-TE
Jamesbury 351T	---
Apollo 70-100	Apollo 70-200
Equal	
  2. Gate Valves, 2-inch and Smaller:  
Class 125, body and bonnet ASTM B62. Cast bronze composition. Threaded or soldered ends. Solid disc, copper-silicon alloy stem, brass packing gland. Threaded ends: Stockham B-100 (RS) or B103 (NRS), Crane 428 or 438, Hammond IB640 (RS) or IB645 (NRS), or equal. Soldered ends: Stockham B104 (NRS) or B108 (RS), Milwaukee 115 (NRS) or 149 (RS), NIBCO S-113 (NRS) or S-111 (RS), or equal.
  3. Gate Valves, 2 ½-inch and Larger:  
Class 125 iron body, bronze mounted, ASTM A126, class B cast iron, flanged ends with Teflon impregnated packing and 2-piece packing glass.

OSY RS	NRS
Stockham	G-623      G-612
Crane	465 1/2      461
Powell	1793      1787
Hammond	IR1140      IR 1138
Equal	
  4. Butterfly Valves: 150 psi tight shut-off, ASTM A126.
    - a. Body: Lug type, ASTM A126iron.
    - b. Disc:
      - 1) For motorized valves: 304 Stainless Steel.
      - 2) For Manual Valves: Cadmium-plated ductile, iron for chilled water (bronze, or aluminum bronze for condenser water).
    - c. Stem:
      - 1) For motorized valves: 416 Stainless Steel.
      - 2) For manual Valves: Solid one-piece, 304 or 316 or 410 stainless steel.
    - d. Seat and O-rings: EPDM O-ring.
    - e. Upper and lower stem bearings: Bronze or reinforced Teflon.
    - f. Operators:
      - 1) Valves 6-inch and smaller: Bray Series 21 as basis of design or Center Line, Stockham, Crane, Belimo, Nibco or equal, with lever handle, or Electric Actuator and disc position indicator.
      - 2) Valves 8-inch and larger: Bray Series 21 as basis of design or Center Line, Stockham, Crane, Belimo, Nibco or equal, manual gear operator and disc position indicator, or Electric Actuator.

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- g. Manufacturers: Bray, Milwaukee, Center Line, Stockham, Crane, DeZURIK, Belimo, Nibco or equal.
5. Check Valves, 2-inch and Smaller:  
Shall be of class 125, threaded or solder ends, body and caps shall be of ASTM B62 cast bronze composition, swing type disc.
- | <u>Threaded</u> | <u>Solder</u>   |
|-----------------|-----------------|
| Stockham B-319Y | Stockham B-309Y |
| Hammond IB 904  | Hammond IB 912  |
| Crane 37        | Crane 1707S     |
| Powell 578      | Powell 1825     |
| Equal           |                 |
- a) Class 150 valves meeting above Specifications may be furnished where pressure requires: Stockham B-321, NIBCO T-433-B, Milwaukee 515, or equal, threaded.
6. Check Valves, 2 ½-inch and Larger:  
Shall be iron body, bronze mounted with body and cap conforming to ASTM A126, class B, cast iron, flanged ends, swing type disc.
- |          |        |
|----------|--------|
| Hammond  | IR1124 |
| Stockham | G-931  |
| Crane    | 373    |
| Powell   | 559    |
| Equal    |        |
7. Alternative Check Valves, 2 ½-inch and Larger:  
Shall be class 125/250, iron body, bronze mounted, wafer check valves, with ends designed for flanged type connection, aluminum bronze disc, EPDM seats, 316 stainless steel torsion spring, and hinge pin.
- Stockham WG-961  
Center Line Series 800  
Duo-Chek K12 HAP  
Marlin M125 HZDSF  
Equal
8. Non-Slam Check Valves (Pump Discharge):  
Semi-steel body, bronze trim, top and bottom center guide, stainless steel spring and 125 pound flanged ends. Miller Manufacturing No. 162 or equivalent by Williams-Hager, Val-Matic Valve & Manufacturing Corp., or equal.
9. Air Vents: Spirotherm model Spirovent as basis of design or Amtrol, Watts, Dole, Bell and Gossett, or equal, manual type, of size for proper venting. Install at high points of systems.
- D. Valves: Heating Hot Water, and Low-pressure Steam System.
1. Gate Valves, 2-inch and Smaller: Shall be of class 150 with body and union bonnet of ASTM B62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon stem, brass packing gland, Teflon-impregnated packing, and malleable handwheel.
- | <u>Threaded</u>     | <u>Solder</u> |
|---------------------|---------------|
| Stockham B-120 (RS) |               |
| Hammond IB629       | Hammond IB648 |
| Crane 431UB         |               |

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- Powell 2714  
Equal
2. Ball Valves, 2-inch and Smaller: Shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.
- | <u>Threaded</u>                    | <u>Solder</u>                      |
|------------------------------------|------------------------------------|
| Stockham T-285-FB-R-70 (full port) | Stockham S-285-FB-R-70 (full port) |
| Crane 9301                         | Crane 9302                         |
| Worcester 44-11-RT-SE              | Worcester 44-11-RT-TE              |
| Jamesbury 351T                     | ---                                |
| Apollo 70-100                      | Apollo 70-200                      |
| Equal                              |                                    |
3. Gate Valves, 2 ½-inch and Larger: Shall be class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A126, class B, cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.
- |          | OS & Y  | NRS    |
|----------|---------|--------|
| Stockham | G-623   | G-612  |
| Hammond  | IR1140  | IR1138 |
| Crane    | 465 1/2 | 461    |
| Powell   | 1793    | 1787   |
| Equal    |         |        |
4. Check Valves, 2-inch and Smaller: Shall be class 150 with body and cap of ASTM B62 bronze composition and threaded ends. Class 150 valves shall have lift-type non-metallic disc and union caps, and are to be furnished in lines with globe valves.
- a) For backflow prevention in lines with gate valves, Y-pattern valves with swing-type disc may be furnished.  
Stockham B-322B  
Crane 27TF  
Equal
- b) For class 150 service, threaded ends:  
Stockham B-321                      Crane 137  
NIBCO T-433-B  
Equal
- c) For class 200 Service, threaded ends:  
Hammond IB944                      Crane 36  
Stockham B-345                      Powell 560  
Equal
5. Check Valves, 2 ½-inch and Larger: Shall be iron body, bronze mounted, with body and cap conforming to ASTM A126, class B, cast iron, flanged ends, and swing-type disc.
- |            |                |
|------------|----------------|
| Crane 373  | Hammond IR1124 |
| Powell 559 | Stockham G-931 |
| Equal      |                |
- a) Alternative for above listed check valves shall be class 125/250 iron body, bronze mounted, wafer check valve, with ends designed for flanged type

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connection, aluminum bronze disc, EPDM seats, 316 stainless steel  
torsion spring, and hinge pin.

Center Line Series 800	Hammond IR9253
Marlin M125 HZDSF	Duo-Chek G12 HAP
Stockham WG-961	Equal

6. Automatic valves controlling steam to a coil in a hot water tank shall be single seated type. When these valves are installed on a gravity return system, they shall be two position type (i.e. completely open or completely closed).
7. Valves on steam mains in boiler rooms shall be angle globe valves and be set to hold no condensate.
- E. Electric Motor Operated Valves: Belimo, Bray or equal.
- F. Valves, General:
  1. Handles or hand wheels on valves shall be removable and, unless specified to be of loose key type, shall be securely fastened to their stems. Valve handwheels, except those on radiator valves, shall be of steel, brass, or cast iron.
  2. Boiler shut-off valves and valves on steam mains installed more than 6 feet above floor, shall be furnished with chain wheels and chains to within 6 feet of floor. Chains shall be free hanging and in a position to permit operation of valve from floor. When pulleys or extensions are required to locate these chains in such a position, furnish, and install said pulleys or extensions as required to provide a satisfactory operating installation. Extensions over one foot long shall be furnished with a supported outboard bearing.
  3. Furnish and install chains or wire rope with required accessories to open safety valves from boiler room floor.
  4. Radiator or convector valves shall be corner or angle type with composition handles, composition renewable discs, packing gland, union nut on tailpiece, unless otherwise specified. If exposed, they shall have a finished or plated exterior.
  5. Temperature Control Valves: Refer to Section 23 0513.
  6. Flow Control Valves: Refer to Section 23 0513.
- G. Flow Measuring Devices: Refer to Section 23 0513.
- H. Strainers: Refer to Section 23 0513.
- I. Condensate Drain Piping, from Air Handling Units: Refer to Section 22 0513.
- J. Indirect Drains, Relief Valve Discharge Piping and Air Vent Discharge Piping:
  1. Pipe: Type L tempered copper water tube.
  2. Fittings: Wrought copper. Refer to Section 23 0513. Furnish copper to threaded international pipe size adapters at threaded connections.
  3. Joints:
    - a. Soldered: 95/5 solder.
- K. Insulation: Refer to Section 23 0700.
- L. Pipe Anchors, Pipe Guides, Expansion and Contraction Devices:
  1. Piping subject to expansion or contraction shall be fastened in a manner permitting strains to be evenly distributed and alleviated by swing joints or expansion loops or joints. Seismic restraints shall be installed so as not to interfere with expansion and contraction of piping.
  2. Provide anchors in heating or cooling piping system, to restrain and control direction of movement for expansion or contraction in piping system.

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3. Provide guides at specific locations in heating or cooling piping system in conjunction with slip or bellows type expansion joint.
  4. When coils or unit housings are shock or vibration isolated, provide piping flexible metal connector not less than 10 inches long whether they are indicated on the Drawings or not.
- M. Flexible Metal Connectors:
1. Provide vibration elimination flexible metal connectors on chilled and hot water supply and return piping where rigidly supported pipes connects to unit housing coil attachments and units are supported by vibration isolators.
  2. Schedule Numbers:
    - a. FMC-1: Corrugated bronze metal hose with outer bronze braid in tubular sheath of woven metal wires. Connector with female copper tube ends for copper piping. Metraflex model BBS, Unisource Style UPCB-BRSW, Microflex, or equal.
    - b. FMC-2: Corrugated stainless steel metal hose with outer stainless steel braid in tubular sheath of woven metal wires. Connector with male pipe threads (NPT) for threaded piping. Metraflex model SST, Unisource Style UPCS-MMT, Microflex, or equal.
    - c. FMC-3: Corrugated Bronze Metal Hose with outer bronze braid in tubular sheath of woven metal wires. Connector with female copper tubes ends for refrigeration piping. Metraflex model RAF, Unisource VIB, Anaconda Vibration Eliminators, or equal.
- N. Refer to Sections 23 0513for following:
1. Pipe Hangers and Supports.
  2. Pipe Sleeves and Plates.
  3. Pipe Flashings.
  4. Relief Valves.
  5. Thermometers.
  6. Pressure Gages.
  7. Pressure and Temperature Test Plugs.
  8. Access Panels.
  9. Dielectric Fittings.
  10. Expansion Tanks.
  11. Condensate Traps.

### 2.02 EQUIPMENT

- A. Furnish centrifugal pumps capable of delivering rated capacity against total dynamic head as indicated on schedule and as specified for following:
1. Condenser Water Pump:
    - a. Single stage base mounted, vertical split case, cast iron, bronze fitted construction. Pump impeller, casing bearings, capable of being serviced without disturbing piping connections.
    - b. Impeller, enclosed type, hydraulically and dynamically balanced and keyed to shaft and secured with a suitable locknut.
    - c. Pump shall employ a mechanical seal, with a carbon seal ring and ceramic (or tungsten carbide) seat. A shaft sleeve furnished under complete wetted area of mechanical seal.

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- d. Bearing frame assembly of pumps fitted with oil lubricated bronze journal bearings and a hardened alloy steel shaft.
  - e. Flexible coupling to absorb torsion vibration between pumps and motor.
  - f. Motor: Resilient mounted, furnished with oil lubricated journal bearings.
  - g. Pump: Factory tested, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. A set of installation instructions to be furnished with pump at time of shipment.
  - h. Acceptable manufacturers: Taco, Armstrong, Paco, Bell and Gossett, Grundfos, Weinman, or equal.
2. Chilled Water Pumps:
- a. Horizontal, split case, fitted same as above, or end suction similar to that indicated below.
  - b. Frame mounted with flexible coupling on shaft.
  - c. Manufacturers: Taco, Armstrong, Paco Bell and Gossett, Weinman, or equal.
3. Hot Water Pumps: End suction, centrifugal, vertical split case, cast iron base mounted. Taco, Armstrong, Paco type L, Bell and Gossett, Grundfos, Weinman, or equal.
4. Boiler Feed Pump: Two-stage, bronze fitted mechanical seals, double suction, regenerative turbine type with cast iron housing. Construction shall permit disassembly of pump without disturbing suction and discharge pipe connections. Pump impeller shall be bronze, mounted on stainless steel shaft supported by ball bearing on each side of pump casing. Pump shall be directly connected with a flexible coupling to an open drip-proof motor and mounted on a common steel base. Pump shall be operated from a boiler water level controller mounted on boiler. Pump shall be Roth Pump Co., Skidmore, Aurora, or equal. Pumps shall be electrically interlocked to 24-hour day/night operating boiler controls.

### **PART 3 – EXECUTION**

#### **3.01 PIPING INSTALLATION**

- A. Install piping systems for chilled water, condenser water, and hot water and steam heating systems, condensate drains, and miscellaneous piping required for equipment, as indicated on Drawings and as specified in Section 23 0513.
- B. All piping and fittings size 2-1/2" and larger shall be welded – No Grooved type fitting is allowed except at chiller barrel and condenser barrel connections.

#### **3.02 WATER PUMPS**

- A. Install water pumps as indicated on Drawings and as specified unless otherwise noted. Provide vibration isolation and flexible pipe connections as specified in Sections 23 0548 and 23 0513.
- B. Floor mounted pumps shall be provided with a 4-inch high concrete base. For base, refer to Section 03 3000: Cast-In-Place Concrete.
- C. Provide leveling and alignment for base mounted pumps before and after installation.
- D. Provide suction diffuser for pumps where space constraints exist.
- E. Install pumps to allow complete removal without having to dismantle connecting pipes.

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- F. Piping shall be supported from building structure to prevent any strain on pump casing. In-line pumps shall be separately supported from piping by furnishing pump manufacturer's specialized spring support kit, if available; pump shall not be rigidly supported.
- G. Flanged connections shall be provided on pumps with a discharge connection larger than 2 inches. Smaller sizes may be furnished with threaded connections. Except for special guided inlet fittings, inlets to suction side of pumps shall be a minimum of 10 diameters of straight pipe free from strainers, valves or fittings. On discharge side, minimum length of uninterrupted length of straight pipe shall be 5 diameters.
- H. Pumps, one horsepower or larger, shall be installed with required pump connections for noise and vibration isolation and not to compensate for misalignment.

**3.03 AIR AND DIRT ELIMINATION**

- A. Heating and chilled water piping and steam or hot water heating and/or cooling equipment shall be installed in a manner so that air will be eliminated from lines or equipment during operation. Pitch pipe lines as specified in Section 23 0513.
- B. Manual air valve shall be installed at each high point of chilled or hot water circulating lines, on each chilled water or hot water heating unit unless unit can vent through outlet connection. Refer to valves as specified under Section 23 0513.
- C. Air vent valves shall be installed with drains to nearest floor sink or outside building.
- D. Air/Dirt separators shall be installed on all hot water heating system, chilled water system, and closed loop fluid cooler system. Units shall be furnished with internal copper coalescing medium to facilitate maximum air and dirt separation and suppress turbulence. Units shall be furnished with galvanized steel strainer and stainless steel collector tube. Provide integral high capacity float actuated air vent at top fitting of tank. Furnish cast iron float actuated air vent rated at 150 psig, threaded to the top of the fitting. Unit shall be furnished with the bottom of the vessel extended for dirt separation with the system connection nozzles equidistant from the top and bottom of the vessel and shall include a blowdown connection and valve. Refer to Air/Dirt separators as specified under Section 23 0513.
- E. Acceptable manufacturers: Spirotherm, Bell and Gossett, Wessels, or equal.

**3.04 CHEMICAL POT FEEDER**

- A. Provide a chemical pot feeder in each of chilled water and hot water systems as specified in Section 23 2500: HVAC Water Treatment.

**3.05 CONDENSER WATER TREATMENT**

- A. Provide condenser water treatment as specified in Section 23 2500: HVAC Water Treatment.

**3.06 CLEANUP**

- A. Remove rubbish, debris and waste material and legally dispose of off the Project site.

**3.07 PROTECTION**

- A. Protect the Work of this Section until Substantial Completion.

**END OF SECTION**

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## SECTION 23 3000 - AIR DISTRIBUTION

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Ductwork and appurtenances required for a complete air transmission and distribution system for the heating, ventilating, and air conditioning systems indicated on Drawings and as specified.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 09 9000: Painting and Coating.
  - 3. Section 23 0500: Common Work Results for HVAC.
  - 4. Section 23 0800: HVAC Systems Commissioning.
  - 5. Section 23 0513: Basic HVAC Materials and Methods.
  - 6. Section 23 0548: HVAC Sound, Vibration and Seismic Control.
  - 7. Section 23 0700: HVAC Insulation.
  - 8. Section 23 0900: HVAC Instrumentation and Controls.
  - 9. Section 23 0923: Environmental Control and Energy Management Systems.
  - 10. Section 23 3813: Kitchen Ventilation System.
  - 11. Section 23 8000: Heating, Ventilating and Air Conditioning Equipment.

#### 1.02 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
- B. Manufacturer's Data:
  - 1. Complete list of items to be furnished and installed under this Section. Material lists that do not require performance data shall include manufacturer names, types and model numbers.
  - 2. Manufacturer's specifications and other data required to demonstrate compliance with specified requirements.
  - 3. Literature shall include descriptions of equipment, types, models, sizes, capacity tables or curves marked to indicate performance characteristics, electrical requirements, options selected, space requirements, including allowances for servicing, and other data. Data shall include name and address of nearest service and maintenance organization that regularly stocks repair parts. Listings of items that function as parts of an integrated system shall be furnished at one time.
  - 4. Submit complete acoustical test reports showing that proposed products have been tested in accordance with latest editions of relevant ASHRAE and AHRI Standards (ANSI/ASHRAE Standard 70 for air inlets and outlets; ANSI/ASHRAE Standard 130 and AHRI 880 for terminal units) and will be suitable for operation in Project spaces with specified maximum noise criteria (NC) requirements. The results of all testing shall be certified by an independent testing agency and submitted to the ARCHITECT for approval. The submittal shall include a complete description of the test conditions, methods and procedures.
  - 5. Submittals shall include a tabulation of proposed products, identification of Project spaces where proposed products are to be installed, maximum

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allowable NC for all Project spaces, and product NC (at specific design air volume) for all Project spaces.

6. Shop Drawings: Shop Drawings indicating methods of installation of equipment and materials, sizes and gages of ducts, and details of supports. Items to be covered shall include but not be limited to following:
  - a. Layout of ductwork and equipment drawn to scale to establish that equipment will fit into allotted spaces with clearance for installation and maintenance. Indicate proposed details for attachment, anchoring to, and hanging from structural framing of building. Indicate vibration isolation units, foundations, supports, and openings for passage of pipes and ducts.
  - b. Drawings indicating locations and sizes of sleeves and prepared openings for pipes and ducts.
  - c. Typical details of supports for equipment and ductwork.

**1.03 QUALITY ASSURANCE**

- A. Installer's and Manufacturer's Qualifications: Comply with provisions stated under Section 23 0500: Common Work Results for HVAC.
- B. Sound power level measurements and Manufacturers' NC value calculations shall be conducted in complete accordance with the latest version of ANSI/ASHRAE Standards 70 and 130 and AHRI 880.

**1.03 DELIVERY, STORAGE AND HANDLING**

- A. Comply with provisions stated in Section 23 0500: Common Work Results for HVAC.
- B. Ensure ducts are clean and free of dirt, dust, moisture, oils and other contaminants that can lead to poor air quality. Cover openings of ductwork with a self-adhering protective film. Film shall not leave a residue on metal after removal, and shall be highly resistant to tears and punctures.

**1.05 COORDINATION**

- A. Coordinate activities in accordance with provisions of Section 23 0500: Common Work Results for HVAC.

**PART 2 – PRODUCTS**

**2.01 GENERAL**

- A. Unless otherwise noted, provisions, including amendments thereto, of the latest edition of the HVAC Duct Construction Standards of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) and the California Mechanical Code (CMC), are hereby made part of this Section.
- B. Rectangular, round and flat oval ducts shall be manufactured and installed in accordance with requirements of the latest edition of the HVAC Duct Construction Standards – Metal and Flexible of SMACNA.
- C. Sheet metal ducts shall be fabricated from galvanized steel, aluminum or stainless steel.
- D. Galvanized steel ducts shall be fabricated of galvanized steel sheet, lock forming grade, conforming to ASTM A653 and A924.
- E. Galvanized steel ducts gage thickness and permissible joints and seams of ductwork shall conform to requirements of the latest edition of the HVAC Duct Construction Standards – Metal and Flexible of SMACNA and the CMC unless noted otherwise on the drawings. The more stringent requirements shall prevail.

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- F. Button punch snap-lock seams, using Lockformer or equal, shall be permitted only in concealed areas using 20 and 22 gage galvanized steel ducts with screws added at the ends. Button punch snap-lock is not permitted for aluminum or duct lighter than 22 gage.
- G. Ducts shall be reinforced in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards: Cross-broken Duct: Duct sizes 19 inches wide and larger which have more than 10 square feet of unbraced panel shall be beaded or cross-broken. This requirement is applicable to 20 gage or less thickness and 3 inches w.g. or less pressure. For details, refer to SMACNA manual.
- H. Round and Oval Galvanized Steel and Aluminum Ducts:
  - 1. Round Spiral Ducts and Fittings: Fabricated from galvanized sheet steel shall be machine-formed spiral pipe with sealed spiral locking joints. Fittings shall be furnished with continuous corrosion-resistant welds. Provide gages of ducts and fittings recommended by manufacturer.
  - 2. Details of seams and transverse joints for round duct and fittings shall conform to SMACNA standards.
  - 3. Flat oval ducts shall be provided as indicated on the Drawings. Reference standard details in SMACNA manual.
  - 4. Minimum duct wall thickness, and permissible joints and seams of ductwork for flat oval duct construction shall conform to requirements in the latest edition of the HVAC Duct Construction Standards – Metal and Flexible of SMACNA and the CMC. The more stringent requirements shall prevail.
  - 5. These provisions apply for ducts furnished for indoor comfort heating, ventilating and air conditioning service only.
- I. Flexible Ducts
  - 1. Flexible duct shall be non-metallic, insulated for conditioned air supply and return. The flexible ducts shall be factory fabricated with exterior reinforced laminated vapor barrier, 1 ½-inch thick fiber glass insulation (K = 0.25 at 75 degrees F), encapsulated zinc-coated spring steel wire helix and impervious, smooth, non-perforated interior vinyl liner and factory fabricated steel connection collars. For the composite assembly, including insulation and vapor barrier, comply with NFPA Standard 90A or 90B and tested in accordance with UL Standard, UL 181. Non-insulated metallic ducts shall be provided for exhaust only.
  - 2. Methods of installations, standards for joining and attaching, and supporting flexible duct shall conform to applicable provisions of SMACNA manual.
  - 3. Specifications herein shall not supersede installation requirements by flexible duct manufacturer if those are more stringent.
- J. Aluminum Ducts:
  - 1. Material for aluminum duct shall be of 3003-H14 alloy aluminum sheets, with such designation embossed or stenciled on each sheet. Minimum tensile strength shall be 19,000 psi.
  - 2. Aluminum duct thickness and permissible joint and seams shall conform to requirements of the latest edition of the HVAC Duct Construction Standards-Metal and Flexible of SMACNA, and CMC.

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3. Aluminum ductwork shall be furnished to transport moisture-laden air from shower rooms, shower drying rooms, dishwashers and discharge ducts from evaporative condenser and cooling towers.
  4. Unless otherwise noted, follow SMACNA Duct Construction Details for steel construction standards as indicated for unreinforced duct, reinforced duct, or cross-broken duct.
  5. Button punch snap-lock seams on aluminum ducts are not permitted.
- K. Stainless Steel Duct:
1. Materials for stainless steel duct shall be stainless steel conforming to ASTM A167 and A480.
  2. Stainless steel ducts shall be provided as required and indicated on the Drawings.
  3. Fume hood exhaust shall be stainless steel Type 304.
  4. Kitchen exhaust duct system shall be stainless steel Type 304.
  5. Stainless steel ducts shall be constructed with welded joints except for connections to equipment which shall be flanged joints with gaskets.
  6. Entire stainless steel duct systems shall comply with current CMC requirements for product conveying ducts except where the requirements of this Section are more stringent.
- L. Fittings and Other Construction Details: Details of fittings such as elbows, turning vanes, branch take-off and connections, duct access doors, connections for grilles, registers and ceiling diffusers, flexible connector at fan, etcetera, shall conform to applicable provisions of this Section or SMACNA manual.
- M. Duct Seam and Joint Sealant: Provide sealant for metal ducts at duct joints which are defined as transverse joints between duct sections including girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections, access doors and frames, and abutments to building structure. Also provide the same at duct seams which are defined as longitudinal joint between duct sections. Spiral lock seams in factory fabricated round or oval ducts are excluded.
1. Sealant for low-pressure ducts shall be: Design Polymeric DP1010 or DP1020, Childers CP-145A/CP-146 Chil-Flex, Foster's 32-19 Duct-Fas, Miracle-Kingco Glenkote Seal-Flex, Ductmate Industries PROseal or FIBERseal, or equal.
  2. Provide sealing material for medium-pressure ducts as described in the SMACNA manual for those pressures.
  3. Sealant materials shall comply with the flame spread and smoke developed rating of current CMC when tested in accordance with ASTM E84.
  4. Sealant for exposed to weather ducts shall pass the Weather Resistance Test per ASTM G154 at 2000 hours QUV.
- N. Restrictions:
1. Zinc-coated steel duct shall not be installed for ductwork transporting moisture-laden air. Flexible duct may only be furnished where specifically indicated on Drawings. Aluminum ducts shall not be installed for internal pressures above 2 inches of water.
  2. Fiberglass duct is not permitted as a substitute for sheet metal duct.

## **2.02 DAMPERS**

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- A. Manually Operated Volume Control Dampers:
1. VD-1, Rectangular: Multi-blade type, opposed blade operation, 16 gage galvanized steel blades; center pivoted on 3/8 inch diameter steel trunnions; interlocking edges; dampers shall be in own angle frame, full duct size as indicated on Drawings; frame of minimum 16 gage steel channel construction. Provide with damper operator and axles positively locked to blade. Ruskin MD35, Pottorff MD-42, Greenheck MBD-15 or equal.
  2. VD-2, Round: Frame shall be constructed of not less than 20 gage galvanized steel, blades of not less than 20 gage galvanized steel channel construction with factory neoprene seals, ½ inch diameter axle shafts and locking hand quadrant. Ruskin MDRS25, Greenheck MBDR-50, or equal.
  3. VD-3, Oval: Frame shall be constructed of not less than 14 gage galvanized steel channels with factory blade seals of not less than 12 gage galvanized steel with not less than ½ inch diameter axle shafts. Provide Ruskin standard construction for frame, blade and axle size, thickness and material variation. Provide adjustable locking hand quadrant. Ruskin CDO25, or equal.
- B. Motorized Volume Control Dampers:
1. MVD-1, Rectangular: Multi-blade type opposed blade operation, 16 gage minimum steel channel frame construction; 16 gage galvanized steel blades center pivoted on ½ inch diameter steel trunnions. Interlocking edges. Dampers shall be in own angle frame. Full duct size as indicated on the Drawings. Provide with matching two position motorized actuator with linkages, 24VAC by Belimo, Honeywell, Invensys, or equal. Ruskin CD35, Pottorff CD-42, Greenheck VCD Series, or equal.
  2. MVD-2, Round: Butterfly type constructed with minimum 20 gage galvanized steel frame with steel angle reinforcement on above 20-inch diameter. Blade shall be 14 gage minimum thickness. Neoprene seal to ensure air tightness in closed position. Furnish with matching two position motorized actuator with linkage 24 VAC by Belimo, Honeywell, Invensys, or equal. Ruskin CDRS25, American Warming and Ventilating (AMV) VC-25, Air Balance, Inc. AC530, or equal.
  3. Electronic Damper Actuators: Belimo, Honeywell, Invensys, or equal.
    - a. Sized for torque required for damper seal at load conditions.
    - b. Coupling: V-bolt dual nut clamp with a V-shaped toothed cradle. Aluminum clamps or set screws are not acceptable.
    - c. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. Actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
    - d. Power Requirements: As indicated on Drawings.
    - e. Actuator Timing: Shall meet 15 seconds.
    - f. Temperature Rating: Actuator shall have a UL 555S listing by damper manufacturer for 350 F.
    - g. Auxiliary Switches: Provide for signaling, fan control, and position indications.
- C. Automatic Fire Dampers:



1. FD, Fire Dampers: Shall conform to requirements of and be listed by State of California Fire Marshal and NFPA 90A. Dampers shall provide airflow resistance not to exceed 0.05 inch water gage static pressure at 900 fpm or 0.25 inch water gage at 2,000 fpm. Dampers shall be installed in required steel sleeve at each penetration of a rated partition.
    - a. Vertical-mounted fire dampers: Fire damper shall be curtain type with blades removed from the air stream to allow for maximum free area. Dampers will be provided in factory sleeves as tested and listed by manufacturer. Dampers shall be rated for 1 ½ hours for installation in one or 2-hour partitions. Provide UL listed fusible links of adequate size and temperature rating. Dampers will be installed according to the manufacturer's recommended installation instructions provided with units. Provide suitable access for inspection and servicing of each damper. Pottorff VFD-10/VFD-10D Series, Ruskin IBD/DIBD Series, Greenheck FD/DFD Series, or equal.
    - b. Ceiling fire dampers: Ceiling fire dampers shall be butterfly type with ceramic material to minimize heat radiation. Dampers shall be rated for one hour and shall be furnished as a part of an integral sleeve ceiling box that will accept air distribution, have a UL listed and pre-mounted hanger tabs. Dampers shall be installed according to the manufacturers recommended installation instructions. Pottorff CFD-15 Series, Ruskin CFD Series, Greenheck CRD-1 Series/CRD-2, or equal.
    - c. Combination fire and smoke dampers: Combination fire and smoke dampers shall be louver bladed type. Units shall be tested and listed under UL 555 and UL 555S. Rating 1 ½ hours for installation in one or 2-hour partitions. The seals shall be non-degradable steel to steel. Leakage shall not exceed 15 cfm/sq. ft. at one inch w.g. and shall be tested at 850 degrees F. Dampers shall be capable of being remotely controlled and reset for pressurization and smoke evacuation. Fire-releasing device shall be UL 33 listed melting fusible links. Dampers shall be provided in sleeves with pre-mounted non-stall motor actuators and dual-position indicators for remote annunciation, if required. The complete assembly shall be factory cycled and tested prior to shipment. Provide suitable access for inspection and servicing of each damper. Pottorff FSD-141 with non-stall motor, Ruskin FSD37 or FSD60 with electric fuse link Model EFL 200, with electric non-stall motor, Greenheck FSD Series, with non-stall motor, or equal.
  2. Electronic Damper Actuators: Refer to Sub-paragraph 2.04.B.3.
- D. Relief Dampers: Parallel multi-blade, counter balanced type with adjustable counter weights. Constructed of 20 gage galvanized sheet steel or extruded aluminum with solid stops all around. Bearings shall be dust proof, ball bearings. Damper shall open on a positive pressure of 0.01 inch within space and close to a backdraft. Interlocking edges shall prevent dust infiltration when closed. Air Balance, Inc., Pottorff, Ruskin, Metal Form Manufacturing Co. Inc., or equal.

- E. Duct Access Panels: Provide factory fabricated access panels in ducts where required for servicing fire or smoke dampers, and at other locations as specified in this Section. Units shall consist of removable panel, gasketed and pressure sealed by controlled spring tension locks. Construct unit, including interior parts, of same material as duct. Units shall be constructed to be suitable for installation in systems of up to 5 inches water gage static pressure.

## **2.03 AIR DISTRIBUTION DEVICES**

A. General:

1. Grilles, registers, diffusers and appurtenances shall conform to requirements specified herein and shall be of type and sizes as specified and indicated on Drawings. Performance shall be in accordance with ANSI/ASHRAE Standard 70 including airflow velocity, pressure, temperature, and sound measurements.
2. Sponge neoprene, rubber, vinyl or felt border gaskets shall be provided for surface-mounted registers, grilles or diffusers.
3. The noise generating characteristics of all specified grilles, registers, and diffusers shall be tested to, and comply with, all requirements of this specification. Representative samples shall be subjected to tests in accordance with applicable standards and procedures in order to demonstrate such compliance. A special test for this project is not required if the manufacturer has previous certified test results that can be made applicable to this project. Maximum Sound Levels of diffusers, grilles and registers shall be as follows:

Administrative office area:	NC 30
Classrooms:	NC 20
Libraries and other noise sensitive areas:	NC 25
Gymnasiums, cafeterias, lockers areas:	NC 30
4. Provide suitable frame types to match the ceiling types as specified or indicated on the Architectural Drawings.
5. Ceiling diffusers shall be provided with equalizing grids.
6. Ceiling mounted grilles, registers and diffusers shall be provided with a factory applied, baked enamel, dull finish, bone white to match acoustical ceiling tile.
7. Grilles or registers mounted on painted walls or other surfaces shall be furnished with a baked prime coat and finish painted in accordance with Section 09 9000: Painting and Coating.
8. Do not provide opposed blade dampers at diffusers and registers to balance the airflow, as they tend to create noise. Provide a manual volume damper at each branch take-off and also at branch duct to each diffuser and register upstream of the flexible duct connections. Air throw patterns shall be as indicated on the drawings.
9. Diffusers, registers and grilles indicated or scheduled on the drawings to comply with special requirements shall take precedence over the standard items specified.

B. Ceiling Diffusers - Round, Square, Rectangular:

1. CD-1 For non-classroom areas of less than 10 feet ceiling height only. Units shall be square or rectangular modular core type as indicated on the

- drawings. Anemostat QC Series, Krueger Model 1240, Price SMCD Series, or equal.
2. CD-2 For typical classrooms. Units shall be square plaque type. Anemostat PG Series, Krueger Model PLQ, Price SPD Series, or equal. The horizontal air discharge pattern shall be 360-degree radial type with factory installed blank-offs for three way, two way corner, two way opposite, or one way discharge pattern.
  3. CD-3 For non-classroom areas of higher than 10 feet ceiling height. Units shall be square or rectangular louver faced type. Anemostat D Series, Krueger Model SH, Price SMD/AMD Series, or equal.
  4. CD-4: Units shall be round, adjustable pattern, and surface-mounted type. Anemostat C-27, Krueger RM Series, Price RCDE Series, or equal.
  5. CD-5: Units shall be adjustable linear slot type. Anemostat SLAD Series, Krueger Model 1900, Price AS Series, or equal.
- C. Grilles - Return, Exhaust, Ceiling, Square, Rectangular:
1. GR-1 Acoustical Tile on Plaster Ceiling: Return and exhaust grilles shall be single deflection type with horizontal fixed face bars set at straight or 45 degree angle, ½ inch spacing and flush and flanged for surface mounting. Anemostat S3HD Series, Krueger Model S80/S85, Price 500/600 Series, or equal.
  2. GR-2 Prefabricated Acoustical Tile Ceiling with Inverted Exposed T-Bars: Return and exhaust grilles shall be with single deflection horizontal fixed face bars, set at straight or 45 degree angle, ½ inch spacing and flush, lay-in panel type with nominal overall dimension of 24-inch by 24-inch. Anemostat Type SAC3L Series, Krueger Model S80/S85, Price 500/600 Series, or equal.
- D. Registers, Supply, Return, Wall:
1. WR-1: Sidewall supply register shall be double deflecting type with loose key-operated opposed blade volume control. Anemostat S2 Series, Krueger Model 80/880, Price 500/600 Series, or equal.
  2. WR-2: Sidewall return register shall be single deflecting type with horizontal fixed face bars set at 45 degree angle flush and flanged for surface mounting and complete with loose key-operated opposed blade volume control. Anemostat S3 Series, Krueger Model S80/S85, Price 500/600 Series, or equal.

#### **2.04 SOUND ATTENUATING EQUIPMENT - DUCT SILENCERS**

- A. Provide factory fabricated duct silencers of tubular or rectangular type, for high or low velocity service, with arrangements, sizes and capacities as indicated on Drawings. Construct silencers of galvanized steel with casing seams sealed or welded to be airtight at a pressure differential of 8 inches water gage between inside and outside of unit, and stiffen or brace as required to prevent structural failure or deformation at same condition, or audible vibration during normal operation. Filler material shall comply with the following:
- |                             |                                    |
|-----------------------------|------------------------------------|
| Fire Safety Standards:      | NFPA 90A and 90B                   |
| Temperature:                | ASTM C411                          |
| Air velocity:               | ASTM C1071, UL 181                 |
| Fire Hazard Classification: | ASTM E84, UL 723-Class 1, NFPA 255 |

**Air Distribution - 233000**

Corrosion Resistance: ASTM C739, C665  
Fungi Resistance: ASTM G21  
Water Vapor Sorption: ASTM C1104, less than 1 percent by weight  
Formaldehyde, Phenoloc Resins or other Volatile Organic compounds: 0 percent.

- B. Select and provide silencers from acoustical and aerodynamic rating tables based on actual test readings or interpolated values of such readings obtained from tests made by recognized independent laboratories. Tests shall be in accordance with ASTM E477.
- C. Select and provide silencers for air pressure drops not exceeding those indicated on Drawings, and of types, sizes and models for which noise reduction values, dynamic insertion loss, in decibels reference 10 to 12 watts, are not less than indicated on Drawings.

## **2.05 ZONE TEMPERATURE CONTROL DEVICES**

- A. Variable Air Volume Control Terminals:
  - 1. VAV-1: AHRI 880 certified, single duct, pressure independent, variable air volume control terminal with reheat coil, sound attenuators, multi-point flow sensor, electric actuators and electronic direct digital controls. The controllers shall comply with Section 23 0923: Environmental Control and Energy Management Systems. The coils shall be copper tubes with copper fins. Casings shall be 22 gage galvanized steel lined with minimum ½ inch, 1.5 pound density, foil faced insulation that complies with NFPA 90A and UL 181. Anemostat, Krueger, Price, or equal.

## **2.06 SMOKE DETECTORS**

- A. Refer to Section 28 3100: Fire Detection and Alarm.

# **PART 3 – EXECUTION**

## **3.01 EXAMINATION**

- A. Examine areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

## **3.02 DUCTWORK**

- A. Construct ductwork according to details of fabrication and methods of support, as indicated in the SMACNA manuals and CMC, unless specified or indicated otherwise in this Section or on Drawings. In event of conflict, the most stringent requirement shall be provided.
- B. Unless otherwise required, construct ducts to conform accurately to dimensions indicated and to be straight and smooth on inside, with joints neatly finished.
- C. Duct dimensions indicated are net inside dimensions.
- D. Where aluminum is welded, provide a minimum thickness of 16 gage, and use gas inert tungsten process of welding.
- E. Anchor ducts to building structural slab, framing and roof decking and detail method of anchoring and fastening if not indicated on Drawings. Supports shall be seismically constructed as required by the latest edition of the SMACNA guidelines.
- F. Construct and install ducts to be completely free from vibration under operating conditions.

- G. Indicate on layout drawing, required for suspended ductwork, location of supports, loads imposed on each fastening or anchor, typical details for anchorage, and details for special anchorage for supports attached to metal roof decking.
- H. Attach supports only to building structural framing members and concrete slabs.
- I. Where supports are required between structural framing members, detail and install suitable intermediate metal framing.
- J. Ducts transporting air-conditioned or heated supply air shall be insulated in accordance with requirements of Section 23 0700: HVAC Insulation.
  - 1. Ducts exposed to weather shall be prefabricated double wall type from HVAC equipment through building envelope.
- K. Ferrous angles and structural members and joining collars specified for construction and support of ductwork and plenums shall be primed with one heavy coat of required asphaltic aluminum paint before installation or fabrication. Metal surfaces shall be thoroughly cleaned before installation of paint. Galvanizing may be provided instead of painting. Installed duct hanger rods concealed in furred ceilings and walls are not required to be primed or painted.
- L. Broken places in galvanized coating shall be acid washed and then completely soldered over or painted with galvanizing paint.

### **3.03 DUCT CONSTRUCTION**

- A. Minimum ductwork gages, joints, reinforcing, and bracing of ductwork shall conform to SMACNA and CMC. The most stringent standards shall prevail. Additional bracing shall be provided to prevent objectionable panel vibration.
- B. Button punch snap-lock seams, using Lock-former or equal, shall be permitted only in non-accessible areas using 20 and 22 gage galvanized steel ducts with screws added at the ends. Button punch snap-lock is not permitted for aluminum or duct lighter than 22 gage.
- C. Provide longitudinal seams of the grooved snap lock, or Pittsburgh and standing, sealed spiral or continuously welded.
- D. Ferrous angles and structural members and joining collars specified for the construction and support of ductwork and plenums shall be primed with one heavy coat of asphalt aluminum paint before installation or fabrication. The metal surface shall be thoroughly cleaned before application of the paint. Galvanizing may be provided instead of painting. Installed duct hanger rods concealed in furred ceilings and walls is not required to be primed or painted.
- E. Broken places in galvanized coating shall be acid washed and then completely soldered over or painted with galvanizing paint.
- F. S-type or drive-slip type girths or longitudinal seams shall not be furnished for ductwork installed outdoors or mounted on roofs.
- G. Broken places in galvanized coating shall be acid washed and then completely soldered over or painted with galvanizing paint.

### **3.04 DUCT ELBOWS AND TURNING VANES**

- A. Duct elbows, including supply, exhaust, and return, shall be provided with a centerline radius of 1.5 times duct width parallel to radius whenever possible; centerline radius shall not be less than width of duct parallel to radius.
- B. Where space does not permit above radius, or where square elbows are indicated on Drawings, turning vanes shall be installed whether indicated on Drawings or not.
- C. Turning vanes shall conform to SMACNA and CMC.

**3.05 DUCT JOINTS AND SEAMS**

- A. Conditioned air supply ducts shall be furnished with joints and seams sealed, welded for air tightness, except spiral seam factory machine formed duct components. Spiral seam is exempted. Joints between slip-fit components may be assembled with all seams and joint connections fastened with screws.
- B. Other ducts shall be furnished with joints and seams sealed by using sealant, taping, soldering, or welding. Ducts for grease hood exhaust shall be furnished with grease-tight welding or brazing on external surface for joints and seams. Fiberglass ducts shall be provided with a thermally activated closure system, Johns Manville Fortifiber Therm-Lock with Automatic Bond Indicator dots, or equal.
- C. S-slip or drive-slip type girths or longitudinal seams are not permitted on exterior or exposed rooftop mounted ductwork.
- D. Caulking, taping, or other joint or seam treatment shall be provided in accordance with recognized standards.
- E. Seams around fan, coil housing and plenums shall be sealed with gaskets or sealing compound to provide an airtight assembly.
- F. Stainless steel ductwork connected to range hoods and fume hoods shall be provided with grease-tight, gas tight welded seams, and shall be constructed and installed so that grease or other material cannot become pocketed in any portion thereof, and system shall slope downward toward hood not less than 1/4 inch per lineal foot. Gasketed flanged joints with sealing compound shall be used only at fan and fume hood connections.
- G. Alternative duct connectors such as Ductmate Industries, Mez Industries, or equal may be used if the following conditions are met:
  - 1. One of the specifically listed connectors is submitted and approved by the ARCHITECT and OAR.
  - 2. The correct size connector, application, and gage of material conform to SMACNA Standards.
  - 3. The connector is installed per manufacturer's specifications.

**3.06 DUCT TRANSITION**

- A. Slopes in sides of transition pieces shall be no greater than 1 to 5. Abrupt changes or offsets in duct system are not permitted, except when reviewed by the ARCHITECT.

**3.07 DUCT TEST HOLES**

- A. Holes in ducts and plenums shall be provided for pilot or static tubes for obtaining air measurements to balance or check air systems. Holes shall be covered with neoprene gasketed sheet metal cover or plugged with a fitted neoprene plug chained to duct.

**3.08 SOUND ATTENUATING EQUIPMENT**

- A. Install sound attenuators where required and indicated on Drawings. Refer to manufacturer's instructions for required installation.

**3.09 FLEXIBLE CONNECTIONS**

- A. At points where sheet metal connections are installed to fans or air handling units, or where ducts of dissimilar metals are connected, a flexible connection of commercial grade, Duro Dyne Durolon, Ventfabrics Ventglas, Ductmate Industries Proflex, or equal, non-combustible material shall be installed and securely fastened by zinc-coated steel clinch-type bands or a flange type connection. Inlet and outlet openings shall be axially in-line, maximum deviation of centerline shall be less than 5 percent of diameter or shortest dimension of a rectangular inlet of fan or air handling unit, with

system at rest. Duct end of connection shall be seismically restrained if more than 4 feet from last support.

### **3.10 AIR TERMINAL DEVICES**

- A. General: Install supply devices after ducts, plenums, and casings have been cleaned and blown free of small particles, as specified. Devices shall be aligned to be parallel to ceiling construction or walls and ceiling surfaces, and shall be pulled tightly to compress gaskets and to fit neatly against surfaces.
- B. Diffusers: Support surface mounted ceiling diffusers from angles or channels resting on and fastened to ceiling construction. Do not support from ducts. Install lay-in diffusers on T-bar ceilings with hanger wires from each corner and not supported by ceiling structure. Provide sheet metal adaptor box above each diffuser to allow space for volume controller with round collars for connection to round ducts where indicated on Drawings. Fasten duct-mounted diffusers to duct collars.
- C. Registers and Grilles:
  - 1. Install wall supply registers at least 6 inches below ceiling, unless otherwise indicated. Locate return and exhaust registers 6 inches below ceiling unless otherwise indicated.
  - 2. Support ceiling diffuser type inlets, registers, and grilles as required above for ceiling diffusers.
  - 3. Fasten wall mounted and duct mounted registers and grilles to flanges of duct collars.

### **3.11 DAMPERS**

- A. Manually operated dampers, gravity dampers, fire dampers, and motor operated dampers shall be furnished and installed as specified and indicated. Upon completion of installation, dampers shall be checked, lubricated, and adjusted so that they operate freely, without binding. Dampers shall be of standard commercial manufacture, complete with damper frame. Where painting is required, they shall be shop finished unless otherwise noted.
  - 1. Provide and install manual volume dampers per SMACNA standards to allow balancing per AABC, NEBB or TABB Procedures and Standards whether indicated on the drawings or not.
  - 2. Balancing dampers shall be installed in main supply ducts from fan discharge plenums, where two or more ducts are connected to each plenum, although such balancing dampers may not be indicated. Each zone shall be provided with a manual volume damper. Sheet metal screws shall be installed through handles and into ducts to lock damper in place after test and balance.
  - 3. Each supply, return, and exhaust branch shall be provided with manual volume dampers.
  - 4. Do not provide opposed blade dampers at air inlets and outlets.
  - 5. Each supply, return, and exhaust inlet or outlet shall be provided with a manual volume damper. This damper shall be a minimum of 5 feet upstream of the air outlet and inlets. An acoustic flexible duct should be provided between the outlet and inlet and the damper for concealed ducts.
  - 6. Dampers installed in accessible locations shall be provided with locking and indicating quadrants. Ventfabrics Ventlok, Duro Dyne, Young Regulator Co., or equal.

7. Dampers installed in ductwork in furred ceiling spaces or in roof spaces with less than 30 inches of clearance below beams, joists, or other construction, and where access panels are not provided shall be furnished with damper rods extended below ceiling and terminated with a concealed damper regulation. Ventfabrics Ventlok, Young Regulator Co., Duro Dyne, or equal.
8. Dampers not identified as splitter, extractor, or butterfly dampers shall be of multi-louver type arranged for opposed blade operation. Damper shall be same dimension as adjoining duct and be tight closing. Blades shall not be greater than 9 inches. Dampers shall be not less than 18 gage steel.
9. Motor operated dampers shall be furnished by temperature control manufacturer as part of temperature control equipment and shall conform to requirements of Section 23 0900: HVAC Instrumentation and Controls.
10. Dampers shall be provided with accessible operating mechanisms. Where operators are exposed in finished portions of building, operators shall be chromium-plated with exposed edges rounded. Splitter dampers are not permitted unless specified and reviewed by the ARCHITECT.
11. Dampers shall not be installed in combustion air ducts.
12. Access panels shall be installed for access at each damper's operating mechanism.

**3.12 FIRE AND SMOKE DAMPERS**

- A. Fire dampers or combination fire and smoke dampers shall be installed and accessible at duct penetrations of rated walls and partitions and as required by State Fire Marshal and NFPA 90A, 92A, 92B, and 101.
- B. Fire dampers shall be sized, and adjoining duct enlarged, to assure full size air passage of connecting ductwork.
- C. Install smoke dampers as indicated on Drawings and as required in ducts penetrating smoke isolation separations.
- D. Fire dampers or combination fire and smoke dampers shall be electrically actuated, power open-fail close type, UL 555 and UL 555S classified for 1-1/2 hours.
- E. Provide a service disconnect switch for each and every combination smoke and fire damper.

**3.13 DETECTORS**

- A. Smoke detectors shall be installed in accordance with requirements of the California Mechanical Code.
- B. Smoke detectors shall be installed in systems of over 2000 CFM capacity to detect presence of smoke and automatically shut down air handling units or fans unless it has been verified with the electrical installer that Exception 1 to CMC 609.0: Automatic Shutoffs, regarding automatic shutdown of systems with total coverage smoke detection systems is applied.
- C. Smoke detectors shall be installed in supply system downstream of filters.

**3.14 BACKDRAFT DAMPERS**

- A. Backdraft dampers shall be installed at locations indicated in accordance with the State of California Building Energy Efficiency Standards, Title 24, CCR.

**3.15 DUCT SLEEVES AND PREPARED OPENINGS**

- A. Furnish duct sleeves for 15-inch diameter ducts or less passing through floors, walls, ceilings, or roof and install during construction of the floor, wall, ceiling, or roof. Install round ducts larger than 15 inches diameter and square and rectangular ducts passing



through floors, walls, ceilings or roof through prepared openings. Provide duct sleeves and prepared openings for duct mains and duct branches.

- B. Provide one inch clearance between duct and sleeve or between insulation and sleeves for insulated ducts, except at grilles, registers and diffusers.
- C. Provide prepared openings for round ducts larger than 15 inches in diameter and for square and rectangular ducts with one inch clearance between duct and openings or between insulation and opening for insulated ducts, except at grilles, registers and diffusers.
- D. Provide closure collar of galvanized sheet metal not less than 4 inches wide unless otherwise indicated on Drawings on each side of walls or floors where sleeves or prepared openings are provided except where grilles or diffusers are installed. Install collar tight against surface. Fit sharp edges of collar installed around insulated duct to preclude tearing or puncturing insulation covering vapor barrier. Fabricate collars from round ducts in steel. Provide not less than 4 nails to attach collar where openings are 12 inches in diameter or less and not less than 8 nails where openings are 20 inches in diameter or less.
- E. Pack space between sleeve or opening and duct or duct insulation with commercial grade packing yarn.

### **3.16 FLEXIBLE DUCT RUNOUTS**

- A. Runouts from branches, risers or mains to air terminal units and outlets may be pre-insulated, factory fabricated flexible ducts complying with NFPA 90A. Flexible ductwork shall not exceed 7 feet in length. When required to suspend flexible ducts, furnish hangers of type recommended by manufacturers of pre-insulated flexible duct and install at intervals recommended. Method of attachment to other components of air distribution system for a vapor-tight joint shall be in accordance with printed instructions of flexible duct manufacturer. Bend radius shall be 1-1/2 times diameter of duct, measured from centerline. Bends greater than 90-degree angle are not permitted. Non-metallic flexible duct shall be permitted only in T-bar suspended ceilings.

### **3.17 DUCT HANGERS AND SUPPORTS**

- A. Exposed or easily accessible ductwork: All exposed ducts shall be supported by all-thread Rod as a single hanger and or a trapeze support for rectangular duct work in accordance with requirements of the latest edition of the HVAC Duct Construction Standards – Metal and Flexible of SMACNA.
- B. Non-accessible ductwork: Non-exposed and hidden from sight during regular school operations ductwork, rigid round, rectangular, and flat oval metal ducts, shall be installed with support systems conforming to SMACNA Standards.
- C. Where ducts are installed one above the other, they shall be individually supported on a trapeze of steel angles with 3/8 inch supporting steel rods securely fastened to overhead construction. A minimum distance of 3 inches shall be maintained between ducts wherever possible, but in no event shall distance be less than 2 inches. Minimum sizes of steel angles shall be 1 1/2-inch by 1 1/2-inch by 1/8 inch for duct sizes through 60 inches in greatest dimension, 2-inch by 2-inch by 1/8 inch for duct sizes 61 inches through 84 inches, 2-inch by 2-inch by 3/16 inch for duct sizes 85 inches through 96 inches, and 2-inch by 2-inch by 1/4 inch for duct sizes over 97 inches.

- D. Ducts six square feet area and greater and or minimum 28" round or greater shall be seismically restrained. Refer to Section 23 0548: HVAC Sound, Vibration and Seismic Control.
- E. Hangers shall not be supported by, or fastened to, non-structural members including blocking. Toggle or Molly type bolts are not permitted.
- F. Vertical ducts shall be supported with suitable angles on each side of each duct located at each floor and at intervals not to exceed 8 feet. Angles shall be sized and installed according to SMACNA Standards for required span so that they will be rigid, without bending or sagging.
- G. Roof-mounted ductwork shall be installed a minimum 12 inches above roof and shall be supported by galvanized welded pipe, one on each side, fastened to roof structure, flashed and sealed to roof membrane. Install supports at each turn, unit connections, and each penetration, and space at maximum 6 feet off-center in general. Pitch pockets are not allowed.

**3.18 ACCESS PLATES AND DOORS**

- A. Access plates and doors shall be furnished and installed where stops, valves, fire dampers, fusible links, coils, damper operating mechanism, control equipment, lubrication fittings, air filters, air handling equipment and similar items normally requiring adjustment or servicing are installed in concealed spaces.
- B. Access plates and doors shall be located to permit convenient access to equipment sized to permit removal of equipment for servicing. Access plates shall be no less than 12-inch by 12-inch in clear opening. Proper servicing of equipment requires adequate access for maintenance personnel. Access doors shall not be less than 24-inches by 24-inch, unless otherwise detailed. Two or more valves shall not be located in same access area unless sufficient clearance is provided for operation, servicing and removal of each valve.
- C. Openings in ducts or plenums whose longer dimension does not exceed 12 inches may be covered by a plate of same material as duct, gasketed and fastened to duct or plenum with sheet metal screws.
- D. Access plates in floors shall not be less than 8-inch by 8-inch and shall be carborundum surface brass with cast brass frames anchored into concrete. Access plates in tile walls shall be chromium plated brass and polished. Serrated plates furnished as part of a clean-out assembly are permitted in floors instead of a separate plate.
- E. Access plates and doors in walls and ceilings of finished rooms and in locations normally accessible to students shall be furnished with continuous piano hinges, unless otherwise specified, and a special flush type spring-loaded latch requiring an Allen wrench to operate. Access devices shall be installed after plastering in plaster ground openings.
- F. Access panels or doors penetrating one-hour fire resistive ceilings shall meet code requirements for such openings.
- G. Access panels shall be fire-rated; Milcor, or equal. Access doors shall be as required for installation in openings penetrating one-hour fire resistive ceilings. Access doors shall be furnished with a flush, key-operated cylinder lock, furnished with two keys each, instead of Allen headlock for non-rated ceilings.
- H. Access panels that are part of an integrated ceiling are specified in Section 09 8433: Cementitious Wood Fiber Acoustical Units. Identification markers shall be affixed to

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adjacent supports, under this portion of Work, to indicate location and type of mechanical device to be serviced.

- I. Access panels installed in ducts or plenums located in heater or equipment rooms containing gas-fired equipment shall be furnished with heavy-duty spring closing hinges and refrigerator door type catches unless otherwise required. When these panels are intended for maintenance personnel access, catches shall be operable from both interior and exterior.
- J. Other access panels, except those specified above, shall be furnished with suitable hinges and one or more sash fasteners.
- K. Panels located in ducts and plenums shall be installed with gaskets made of synthetic rubber, felt, or similar material to provide an airtight installation. Panels shall be constructed and reinforced to prevent vibration.
- L. Label the words "FIRE DAMPERS" on panels over fire dampers and words "DO NOT OPEN - HEATER IS OPERATING" on panels located in heater or equipment rooms. Letters shall be approximately 3 inches high, if space is available.
- M. Furnish a key to operate latch access plates, one for each access plate, but not to exceed five keys for any one Project.
- N. Access plates and panels shall be furnished with manufacturer's name or trade mark and model number cast or stamped thereon, or upon a label permanently affixed thereon.
- O. Provide duct through roof flashing as detailed in the SMACNA standards or as indicated on Drawings.
- P. Refer to SMACNA for access plate and door construction.

### **3.19 CLEANUP**

- A. Remove rubbish, debris and waste materials and legally dispose off the Project site.

### **3.20 PROTECTION**

- A. Protect the Work of this Section until Substantial Completion.

**END OF SECTION**

## SECTION 23 8000 - HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Air conditioning and air handling equipment including but not limited to:
  - 1. Single Packaged Air Conditioning Units.
  - 2. Split System Air Conditioning Units.
  - 3. Split System Heat Pump Units.
  - 4. Fans.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Section 07 6000: Flashing and Sheet Metal.
  - 3. Section 22 1000: Plumbing.
  - 4. Section 23 0500: Common Work Results for HVAC.
  - 5. Section 23 0513: Basic HVAC Materials and Methods.
  - 6. Section 23 0548: HVAC Sound, Vibration and Seismic Control.
  - 7. Section 23 0900: HVAC Instrumentation and Controls.
  - 8. Section 23 0923: Environmental Control and Energy Management System.
  - 9. Section 23 2013: HVAC Piping.
  - 10. Section 23 3000: Air Distribution.
  - 11. Section 23 5000: Central Heating Equipment.
  - 12. Section 23 6416: Oil Lubricated Centrifugal Water Chillers.
  - 13. Section 23 6418: Oil Free Centrifugal Water Chillers.
  - 14. Section 23 6423: Scroll Water Chillers.
  - 15. Section 23 6426: Rotary-Screw Water Chillers.
  - 16. Section 23 6428: Air-Cooled Rotary Screw Chillers.
  - 17. Section 23 6500: Cooling Towers.

#### 1.02 DESIGN REQUIREMENTS

- A. Work of this Section is based on HVAC equipment units indicated as Basis of Design in Part 2 of this Section. Products from different HVAC equipment manufacturers listed are never identical, although equivalent in capacity, performance and quality. In the cases where dimensions, weight, configuration and utility requirements differ from the products used as a basis of design, the Contractor, at no additional cost to the Owner, shall coordinate and submit, for Architect review, revisions to the design.

#### 1.03 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
- B. For products listed that are not the basis of design, submit the following in addition to above requirements:
  - 1. Title 24 Calculations: Replace HVAC unit values in calculation files provided by the Architect and submit for review.

#### 1.04 QUALITY ASSURANCE

- A. Provide submittals in accordance with Section 23 0500: Common Work Results for HVAC.

### Heating, Ventilating Air Conditioning Equipment - 238000

**1.05 PROJECT RECORD DOCUMENTS**

- A. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 0500: Common Work Results for HVAC.

**1.06 WARRANTY**

- A. Compressors shall be provided with manufacturer's five year warranty, replacement only.
- B. Manufacturer shall warrant parts, except heat exchangers, for a period of five years.
- C. Heat exchangers shall be provided with manufacturer's ten year warranty, replacement only.

**PART 2 – PRODUCTS**

**2.01 EQUIPMENT**

- A. Capacities of air conditioning equipment indicated on Drawings are net capacities actually required. Standard catalog ratings shall be adjusted to actual Project site environmental conditions.

**2.02 AIR CONDITIONING UNITS - AC (2 Tons-25 Tons)**

- A. Manufacturers: Daiken, Carrier, Trane, York, Lennox, or equal.
  - 1. Basis of Design: Daiken
- B. Furnish packaged air conditioning unit with gas heating for roof top installation. Unit shall be self-contained, completely factory assembled, with complete internal wiring and controls. Unit shall also be provided with a fully piped refrigerant circuit, fully charged with an environmentally friendly refrigerant that is not scheduled for phase out. Unit shall be field configurable for down-flow or horizontal discharge. Cooling and heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
- C. Quality Assurance:
  - 1. Units shall be CSA certified for outdoor installation.
  - 2. Cooling capacity shall be rated in accordance with current ANSI/AHRI Standard 210/240.
  - 3. Unit shall be UL listed and designed to conform to ANSI/ASHRAE Standard 15 Safety Code for Mechanical Refrigeration and ANSI Z21.47-2016/CSA 2.3-2016 Gas
  - 4. ANSI/NFPA 70: National Electrical Code.
  - 5. Unit cooling efficiency EER/SEER ratings shall comply with CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings, and shall not be less than ratings indicated on drawings.
  - 6. Unit heating efficiencies AFUE ratings shall comply with current CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings, and shall not be less than ratings indicated on drawings.
  - 7. Unit shall comply with California Maximum Oxides of Nitrogen (NOX) Emission Regulations and current SCAQMD regulations.
  - 8. The unit roof curbs shall conform to NRCA standards.
  - 9. Insulation and adhesive shall meet NFPA 90A and 90B requirements for flame spread and smoke generation.
  - 10. Unit casing shall be capable of withstanding ASTM B117 500-hour salt spray test.

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11. Each unit shall be run tested at factory per ANSI/ASHRAE 37 and provided with a certificate indicating tested pressures, amperages, dates, and inspector.
- D. Unit Cabinet:
1. Galvanized steel with baked enamel finish on external surfaces that are exposed to weather.
  2. Interior surfaces exposed to conditioned and return air streams shall be insulated with a minimum ½-inch thick, 1 pound density foil-faced cleanable insulation.
  3. Cabinet top cover shall be of one piece construction or where seams exist, shall be double hemmed and gasket sealed.
  4. Cabinet panels shall be hinged access panels for filter, compressors, evaporator fan, control box and heat section areas. Each panel shall use multiple quarter-turn latches. Each major external hinged access panel shall be permanently attached to rooftop unit. Panels shall also include tiebacks.
  5. Return air filters shall be accessible through a hinged access panel and be on a slide-out track using standard size filters.
  6. Holes shall be provided in base rails (minimum 16 gage) for rigging shackles and level travel and movement during overhead rigging operations.
  7. Unit shall have a factory-installed internally sloped condensate drain pan, providing a minimum ¾-inch-14 NPT connection to prevent standing water from accumulating. Pan shall be fabricated of high impact polycarbonate material, epoxy powder coated steel or stainless steel and shall slide out for cleaning or maintenance. An alternate vertical drain (¾-inch NPT) connection shall also be available. Drain pans shall conform to ASHRAE 62 self-draining provisions.
- E. Compressors:
1. Unit shall be furnished with single (If single compressor is used, then it shall be Two Stage type) or multiple fully hermetic scroll compressors with internal vibration isolators.
  2. Dual electrically and mechanically independent refrigerant circuits for 7.5 tons and above.
  3. Compressors shall be provided with service access valves.
  4. Compressor motors shall be cooled by refrigerant passing through motor windings.
  5. Compressors shall be provided with line break thermal and current overload protection.
  6. Compressors shall be provided with crankcase heaters, internal high-pressure and temperature protection.
  7. Compressors on unit rated 90,000 BTU and below shall be of two stage types.
- F. Refrigerant circuit components:
1. Thermostatic expansion valve (TXV) with removable power element.
  2. Refrigerant strainer.
  3. Service gage connections on suction, discharge, and liquid lines.
  4. Solid core refrigerant filter driers.

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- G. Fans and Motors:
1. Evaporator fan shall be a dynamically balanced, double width, double inlet, forward curved centrifugal type, fabricated of steel with a corrosion resistant finish that was tested and rated in accordance with AMCA requirements.
  2. Evaporator fans shall be direct-driven for the AC Units with the cooling capacity of less than or equal to 48,000 BTU/H, and belt or direct-driven for the AC units with the cooling capacity of greater than 48,000 BTU/H, as indicated on Drawings.
  3. Direct drive fans shall be provided with ECM motor.
  4. Evaporator blower and motor shall have permanently lubricated, factory-sealed ball bearings and automatic-reset thermal overload protection.
  5. Belt drive shall include an adjustable-pitch motor pulley. Belt drive fans shall accommodate from 0.6 inch to 1.6-inch external static pressure without changing drives or motors.
  6. Condenser fan shall be a dynamically balanced, propeller type, fabricated of aluminum blades riveted to corrosion resistant steel spiders and direct-driven by a totally enclosed motor. Condenser air shall be discharged vertically. Condenser fan motor shall be high efficiency or ECM type motor and provide cooling operation down to 25 degrees F outdoor temperature with automatic-reset thermal overload protection.
- H. Heating Section:
1. Induced draft combustion type with energy saving direct spark ignition system, redundant main gas valve, and 2-stage heat.
  2. The heat exchanger shall be of tubular section type fabricated of a minimum of 20 gage steel coated with a nominal 1.2 mil aluminum-silicone alloy or 20 gage type 409 stainless steel, including stainless steel tubes, vestibule plate.
  3. Burners shall be of in-shot type fabricated of aluminum coated steel or stainless steel.
  4. Gas piping shall enter unit cabinet at a single location.
  5. Integrated Controls shall provide following:
    - a. Timed control of evaporator fan functioning and burner ignition,
    - b. Anti-cycle protection for gas heat operation (after one cycle on high temperature limit switch and one cycle on flame rollout switch).
    - c. Diagnostic information.
  6. Induced draft motor shall be provided with permanently lubricated, sealed bearings and inherent automatic reset thermal overload protection.
- I. Controls, Safeties and Diagnostic Points:
1. Unit Controls: Unit shall be furnished with self-contained, network capable and ready direct digital controls.
    - a. Controls shall be factory-installed.
    - b. Controls shall operate with zone control systems.
    - c. Controls shall furnish built-in diagnostics for thermostat commands for staged heating and cooling, evaporator-fan operation, and economizer operation.
    - d. Controls shall be furnished with a 5-minute time delay between modes of operation.

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- e. Control circuit shall be protected by a fuse on 24-V transformer side.
- f. Control shall incorporate passive infrared detection for sensing occupancy in space serve.
- 2. Compressor high temperature, high current, internal overloads, internal thermostat.
  - a. Compressor reverse rotation protection.
  - b. Loss-of-charge/low-pressure switch.
  - c. Freeze-protection thermostat, evaporator coil.
  - d. High-pressure switch. The lockout protection shall be easily disconnected at control board, if necessary.
  - e. Internal relief valve.
  - f. Anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle.
- 3. Heating section shall be provided with following minimum protections:
  - a. High-temperature limit switches.
  - b. Induced draft motor speed sensor.
  - c. Flame rollout switch.
  - d. Flame proving controls.
  - e. Redundant main gas valve.
  - f. Heating controls shall consist of:
    - 1) 2-stage automatic combination gas valve.
    - 2) Pressure regulator.
    - 3) Electric spark intermittent ignition system or hot surface ignition system.
    - 4) Time delay fan control.
- 4. Operating Characteristics:
  - a. Unit shall be capable of starting and operating at 125 degrees F ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 210/240 or 360 at plus or minus 10 percent voltage.
  - b. Compressor with standard controls shall be capable of operation down to 25 degrees F ambient outdoor temperature.
- 5. EMS Diagnostic Points: Provide diagnostic points for units, including those at projects with no EMS.
  - a. Supply air temperature.
  - b. Return air temperature.
  - c. Space temperature.
  - d. Outdoor air temperature.
  - e. Filter status.
  - f. Fan status.
  - g. Compressor status.
  - h. Economizer damper current position.
  - i. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
- J. Filter Section:
  - 1. Provide filter section with factory-installed low-velocity, throwaway 2-inch thick high capacity, MERV 8 Class 2, or equal, filters of commercially available sizes unless noted otherwise on the drawings.

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2. Filter face velocity shall not exceed 300 fpm at nominal airflows.
  3. Filter section shall allow installation of standard size air filter.
  4. Return air filters shall be accessible through a hinged access panel using standard size filters.
- K. Furnish programmable digital thermostat with following features for single zone units that are not provided with variable volume and variable temperature type controls:
1. 7-day time clock.
  2. Heat, cool, automatic changeover.
  3. Occupied/unoccupied modes.
  4. Dry contact switch for input from an external device such as a central time clock, occupancy sensor or a telephone activated device.
  5. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors, and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
  6. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in occupancy sensor. Refer to Section 23 0900 for areas with zone damper controls.

**2.03. COOLING ONLY FAN COIL UNITS AND CONDENSING UNITS**

- A. Manufacturer: Daiken Carrier, Trane, York, Lennox, or equal.

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1. Basis of Design: Daiken

- B. FCU and CU: Furnish fan coil unit (FCU) and condensing unit (CU), split type, air-cooled, roof or ground for ducted connections or free blow. Units shall be air-cooled condensing unit/direct expansion fan coil combinations. Condensing unit outdoor section shall be factory assembled with a direct-drive condenser fans with horizontal or vertical air discharge, scroll-type compressor, refrigerant coil, fan motors, pre-wired control panel and a holding charge of a non-ozone depleting refrigerant. Contractor shall provide additional refrigerant for extended lines. Indoor fan coil unit shall be furnished with horizontal discharge and will include evaporator coil, fan and motor, condensate pan with drain, thermal expansion valve, pre-wired control panel and remote thermostat control. Unit shall provide an EER/SEER complying with CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings. UL listed and rated at AHRI Standard 210/240.
- C. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
- D. Condenser coils:
1. Acceptable Condenser Coils:
    - a. Copper-tube, aluminum-fin coil, with liquid subcooler. Internally enhanced 3/8-inch outside diameter, seamless copper tubing mechanically bonded to aluminum fins with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.
    - b. Spine Fin™ condenser coil shall be continuously wrapped, corrosion resistant aluminum with minimum brazed joints. This coil is 3/8 inch outside diameter seamless aluminum tubing glued to a continuous aluminum fin. Coils are lab tested to withstand 2,000

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- pounds of pressure per square inch. The outdoor coil provides low airflow resistance and efficient heat transfer. The coil is protected on four sides by louvered panels.
- c. Coil shall be air-cooled Micro-Channel heat exchanger technology (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.
- E. Condenser Coils shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints. Coated coils are not acceptable.
- F. Condenser Fan and Motors: Condenser fan shall be a dynamically balanced, propeller type, fabricated of aluminum blades riveted to corrosion resistant steel spiders and direct-driven by a totally enclosed motor. Condenser air shall be discharged horizontally or vertically. Condenser fan motors shall be high efficiency or ECM type motor.
- G. Cabinets: Fabricated of galvanized steel, bonderized and finished with baked enamel.
- H. Compressor shall be serviceable two stage or variable speed type hermetic scroll. Compressor shall be furnished with access valves and shall be installed on rubber isolators to reduce sound vibration. It shall be furnished with high and low-pressure protection. Each horizontal discharge condensing unit shall be furnished with a factory installed suction accumulator. Field installed accumulators are not permitted. It shall be furnished with high and low-pressure protection, brass external vapor supply line service valves, vapor return line service valves with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, filter drier, pressure relief, liquid line solenoid valves, thermostatic expansion valves, and a holding charge of refrigerant.
- I. Controls: Compressor motor assembly shall be protected with high and low-pressure switches, internal overloads, internal thermostat, internal relief valve, and anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle. Unit shall incorporate an automatic relay for indoor circulating air blower. Control panel shall be pre-wired in unit casing. The control circuit shall incorporate a manual reset safety circuit to render refrigerant system (compressor and outdoor air motor) inoperative should there be a loss of airflow or refrigerant. Units shall also be furnished with automatic condenser-fan motor protection, high condensing temperature protection, compressor motor current and temperature overload protection, high pressure relief, and condenser fan failure protection.
- J. EMS Diagnostic Points:
1. Supply air temperature.
  2. Return air temperature.
  3. Space temperature.
  4. Filter status.
  5. Fan status.

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6. Compressor status.
7. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
- K. Low Ambient Operation: Head pressure control shall be provided for operation at outside air temperature below 45 degrees F.
- L. Filters: Filters shall be 2-inch standard size high capacity replaceable media type MERV 8, or equal, installed in an external 2-inch rack filter section and complete with an access door.
- M. An in-line filter-drier shall be provided with equipment and shall be installed at Project site.

## 2.04 HEAT PUMP AND FAN COIL UNITS

- A. Manufacturer: Daiken Carrier, Trane, York, Lennox, or equal.

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1. Basis of Design: Daiken
- B. HP and matching indoor fan coil unit and condenser unit: Furnish heat pump, split type, air-cooled, roof or ground installation with ducted connections or free blow. Units shall be air-cooled heat pump/direct expansion fan coil combinations. Heat pump outdoor section shall be factory assembled and furnished with direct-drive condenser fans with horizontal or vertical air discharge, scroll type compressor, refrigerant coil, fan motors, pre-wired control panel. Unit shall also be provided with a fully piped refrigerant circuit, fully charged with an environmentally friendly refrigerant that is not scheduled for phase out. Provide additional refrigerant for extended lines. Indoor fan coil unit shall be furnished with horizontal discharge and will include evaporator coil, fan and motor, condensate pan with drain, thermal expansion valve, pre-wired control panel and remote thermostat control. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
- C. Quality Assurance:
  1. Cooling capacity rated in accordance with current AHRI Standard 210/240 and 270. Units shall be listed in AHRI.
  2. Unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with NEC.
  3. Units shall be constructed in accordance with UL standards and shall carry UL label of approval. Units shall have CSA approval.
  4. Units shall be listed in CEC directory.
  5. Unit cabinet shall be capable of withstanding ASTM B117 500 hour salt spray test.
  6. Unit shall provide an EER/SEER/COP complying with CCR, Title 24, Building Energy Efficiency Standards and per the drawings.
- D. Evaporator and condenser coils: Evaporator and condenser coils shall be copper with mechanically bonded, smooth aluminum plate fins. Tube joints shall be brazed with copper or silver alloy. Coils shall be pressure-tested at factory. Protective metal guard for inlet and outlet of outdoor coil.
- E. Evaporator and Condenser Coils at locations within two miles from ocean shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints. Coated coils are not acceptable.

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- F. Fans:
  - 1. Condenser Fan and Motors: Condenser fan shall be ECM type motor direct driven, propeller type arranged for horizontal or vertical discharge. Condenser fan motors shall be furnished with inherent protection, and shall be permanently lubricated type, resiliently mounted for quiet operation. Each fan shall be furnished with a safety guard.
  - 2. Evaporator fan section shall be furnished with ECM type motor centrifugal, forward curved, double width, double inlet fan or fans installed on a solid shaft. Fan shall be statically and dynamically balanced and shall rotate on permanently lubricated bearings.
- G. Unit Cabinets:
  - 1. Cabinets shall be fabricated of galvanized steel, bonderized and finished with baked enamel.
  - 2. Cabinet interior shall be insulated with minimum one inch thick foil face fiberglass.
  - 3. Outdoor unit compartment shall be isolated and have an acoustic lining to assure quiet operation.
- H. Compressor: Compressor shall be two stage or variable speed type hermetic scroll.
  - 1. Compressor shall be furnished with access valves and it shall be installed on rubber isolators to reduce sound vibration.
  - 2. Furnish with high and low-pressure protection.
  - 3. Each heat pump shall be furnished with factory installed suction accumulator. Field installed accumulators are not permitted.
  - 4. It shall be furnished with high and low-pressure protection, brass external vapor supply line service valves, vapor return line service valves with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, filter drier, pressure relief, liquid line solenoid valves, thermostatic expansion valves, and a holding charge of refrigerant.
- I. Refrigeration Components: Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, bi-flow filter drier, pressure relief, reversing valve, heating mode metering device, and a holding charge of refrigerant.
- J. Controls and Safeties:
  - 1. Compressor motor assembly shall be protected with high and low-pressure switches, internal overloads, internal thermostat, internal relief valve, and anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle.
  - 2. Control panel shall be pre-wired in unit casing.
  - 3. The control circuit shall incorporate a safety circuit to render refrigerant system (compressor and outdoor air motor) inoperative should there be a loss of airflow or refrigerant.
  - 4. Units shall also be furnished with automatic condenser-fan motor protection, high condensing temperature protection, compressor motor current and

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- temperature overload protection, high pressure relief and condenser fan failure protection.
- K. EMS Diagnostic Points:
1. Supply air temperature.
  2. Return air temperature.
  3. Space temperature.
  4. Filter status.
  5. Fan status.
  6. Compressor status.
  7. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
- L. Low Ambient Operation: Head pressure control shall be provided for operation at outside air temperature below 45 degrees F.
- M. Safeties:
1. High condensing temperature protection.
  2. Compressor motor current and temperature overload protection.
  3. High pressure relief.
  4. Outdoor fan failure protection.
- N. Filters:
1. Filters shall be 2-inch standard size high capacity replaceable media type, MERV 8, or equal, installed in an external 2-inch rack filter section and complete with an access door.
  2. An-line filter-drier shall be furnished with equipment and installed at Project site.
- O. Economizer: Provide on units with capacities equal to, or larger than 4.5 tons nominal capacity, when the Prescriptive Compliance approach is utilized to comply with Energy Efficiency Standards or where necessary to achieve CHPS pre-requisite and/or CHPS building flush-out compliance. Economizer shall be manufacturer's standard; factory furnished and field installed. Economizer control shall maintain a fixed supply air temperature during free cooling operation by providing full modulation of operable outside and return air dampers.
- P. Provide programmable digital thermostat with following features:
1. 7-day time clock.
  2. Heat, cool, automatic changeover.
  3. Occupied / Unoccupied modes.
  4. Dry contact switch for input from an external device such as a central time clock, occupancy sensor, or a telephone activated device.
  5. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in occupancy sensor. Refer to Section 23 0900 for areas with zone damper controls.
  6. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
- Q. P. Demand Control Ventilation:

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1. Units of 6.25 nominal tons and higher capacity shall be provided with Indoor Air Quality (CO2) Sensor and Accessory Electronic Expansion Boards.
  2. The unit shall have ability to provide demand ventilation indoor-air quality (IAQ) control through economizer when provided with an indoor air quality sensor and accessory expansion board.
  3. The IAQ sensor shall be duct mounted in return air main duct unless otherwise indicated on Drawings. The set point shall be adjustable.
  4. The IAQ sensor shall be powered through unit. If not, required control transformer shall be provided by manufacturer. Coordinate power requirements and location with Division 26.
  5. The IAQ sensor shall provide a 4 to 20 mA signal to expansion board.
- R. Start-up: Factory test each unit before shipment to Project site. Performance test shall include full refrigeration start-up, fan and controls start-up. Each unit shall be provided with its own report with its own serial number. Non-tested units are not permitted to be delivered to Project site. Provide full start-up of units to include full refrigeration and provide a written report.
- S. Parts Availability: Submit proof in writing that majority (minimum 80 percent) of replacements parts are commonly available and not proprietary. Also, submit proof in writing that a local parts sales and service facility exists, where replacement parts will be warehoused in quantity. Guarantee timely availability for parts that are proprietary.

## **2.05 ROOF MOUNTED POWER EXHAUST VENTILATORS**

### **A. RMEV-1**

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VEBK Series	GB Series	ACEB	Domex-Belt Drive	BCRD	

2. Spun aluminum, roof mounted, belt driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Provide required accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided through curb cap and into motor

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compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.

5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
7. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, or heavy gauge galvanized steel, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

**B. RMEV-2:**

**1. Manufacturer:**

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VEDK Series	G Series	ACED	Domex-Direct Drive	DCRD	

2. Spun aluminum, roof mounted, direct driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak

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protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.

5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

C. RMEV-3:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VUBK Series	CUBE Series	ACRUB	Fumex-Belt Drive	BCRU	

2. Spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.

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5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
7. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron, or galvanized steel type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

D. RMEV-4:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VUDK Series	CUE Series	ACRUD	Fumex-Direct Drive	DCRU	

2. Spun aluminum, roof mounted, direct driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.

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5. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

**2.06 INLINE FANS**

A. ILF-1: (Used as Garage Exhaust Fan GEF-1)

1. Manufacturer:

GREENHECK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
QEI or QEID	ESI	QSL	

2. Provide inline mixed flow type fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA certified ratings seal for sound and air performance.
4. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The housing shall be of minimum 12 gage steel. Bearing supports shall be minimum 10 gage welded steel. Lifting eyes shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
5. Finish: Steel fan components shall be coated with polyester powder coating to exceed 1,000 hour salt spray test under ASTM B117 test method.
6. Wheel: Wheel shall be of mixed flow type with a wheel cone, spherical back plate and single thickness cambered blades, or formed hollow airfoil blades continuously welded to back plate. Hub shall be keyed and securely attached to fan shaft. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
7. Motor: Motor shall be ECM type, voltage and phase, as indicated on drawings. Provide permanently lubricated sealed ball bearings. Option: Energy efficient motor meets EPart and NEMA Table 12-10.
8. Shaft: Blower shaft shall be AISI C1045/SAE 1045, or 1040 hot rolled and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.

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9. Bearings: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing and selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
10. Drive: Fans shall be direct drive or belt driven as indicated on drawings.
11. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

**2.07 CEILING CABINET FANS**

A. CCF-1:

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VCDK or VCDD Series	SP or CSP Series	GC 200 or 900 Series	Zephyr Fans	T or TL Series	

2. Provide ceiling, wall, or inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
4. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard.
5. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

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**B. CCF-2:**

**1. Manufacturer:**

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VCDK or VCDD Series	CSP Series	GN 200 or 900 Series	Zephyr Fans	TL Series	

2. Provide inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
3. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
4. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different mounting positions, an adjustable pre-punched mounting bracket shall be provided.
5. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

**C. CCF-3:**

**1. Manufacturer:**

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
VDBA or VGBA Series	BCF Series	DB	Zephyr Cabinet Fans	DBS or DBT	

2. Provide duct mounted, belt driven centrifugal cabinet fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.

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3. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
4. Housing: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 22 gage galvanized steel with two access doors and integral duct collars. Internal blower and motor assembly shall be mounted on rubber vibration isolators. Hanging brackets shall be provided for horizontal installation. Unit shall bear an engraved aluminum nameplate.
5. Wheel: Wheel shall be DWDI centrifugal forward curved type, constructed of painted steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
6. Motor: Motor shall be heavy duty TEFC inverter duty type with permanently lubricated sealed ball bearings and furnished at specified voltage and phase.
7. Bearing: Bearings shall be permanently lubricated, sealed ball type selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

## **2.08 GRAVITY EXHAUST/INTAKE VENTILATORS**

### **A. GEIV-1:**

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GSAA Series	GRS Series	PR or TR	WCC	GRV	

2. Spun aluminum, roof mounted gravity ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation of ventilators per code and in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength. Birdscreen constructed of 1/2" mesh shall be mounted across air opening. Unit shall bear an engraved aluminum nameplate.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01" static pressure.

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5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

**B. GEIV-2:**

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GEAB Series	FGR Series	GR	AEG Relief	MGR	

2. Provide hooded aluminum, roof mounted gravity relief ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 12 gage Aluminum 5052, hinged to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of ½ inch mesh shall be mounted across relief opening. Unit shall bear an engraved aluminum nameplate.
4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

**C. GEIV-3:**

1. Manufacturer:

CARNES	GREENHECK	LOREN COOK	PENNBARRY	TWIN CITY & BLOWER	OR EQUAL
GIAB Series	FGI Series	GI	AEG Intake	MGI	

2. Provide hooded aluminum, roof mounted gravity intake ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
3. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 18 gage Aluminum, bolted to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of ½ inch mesh shall be mounted across intake opening. Unit shall bear an engraved

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aluminum nameplate. Units shall be provided with bird screen and anti-condensate coating as standard.

4. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
5. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper

## **2.09 FILTERS**

- A. Air filters shall be of pleated, high capacity, disposable type of efficiencies indicated on drawings. Each filter shall consist of a non-woven cotton fabric media, media support grid, and enclosing frame. Filter shall be UL 900 listed, Class 2.
- B. Filter media shall provide an average efficiency as specified on drawings per ASHRAE Standard 52.2.
- C. Initial resistance of air filters shall not exceed following limits for each efficiency level at face velocities indicated. Lower resistance requirements, if indicated on drawings shall have precedence.

30 percent (MERV 8)	0.27 inch water gage at 500 feet per minute
75 percent (MERV 11)	0.28 inch water gage at 500 feet per minute
85 percent (MERV 13)	0.30 inch water gage at 500 feet per minute
95 percent (MERV 14)	0.38 inch water gage at 500 feet per minute
- D. Use standard size Filter Medias only.
- E. Media support shall be a welded wire grid or a rigid frame with an effective open area of not less than 96 percent.
  1. Media support shall be bonded to filter media to eliminate possibility of media oscillation and media pull-away.
  2. Media support grid shall be formed in such a manner that it effectively forms a radial pleat design, providing total use of filter media.
- F. Enclosing frame shall be bonded to air entering and air exit side of each pleat, to ensure pleat stability. Inside periphery of enclosing frame shall be bonded to filter pack, thus eliminating possibility of air bypass.
- G. Holding frames shall be factory fabricated of 16 gage galvanized steel, or equivalent and shall be furnished with gaskets and spring type positive sealing fasteners. Fasteners shall be capable of being attached or removed without use of tools.
- H. Manufacturers: Camfil Farr, Koch, or AAF.

## **2.10 LOUVERS, AIR CONDITIONING (use in conjunction with relief damper)**

- A. Standard steel louvers shall be furnished complete with frames, blades, finish and construction details per Drawings and manufacturer's recommendations.
- B. Louvers shall be furnished with horizontal blades, 2 inches deep for air through wall installation in conjunction with gravity relief damper for backdraft protection that will open at 0.01 inch wc room static pressure as indicated on Drawings. Blades shall be 16-gage steel, spaced at 1 7/8-inch at 30 degrees angle, and with baked epoxy coating. Panel size shall be as indicated but not less than 24 inches width by 18 inches in height.

## **PART 3 – EXECUTION**

### **3.01 GENERAL**

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- A. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

**3.02 EQUIPMENT FOUNDATIONS**

- A. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions imposed upon equipment.
- B. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Foundations shall meet requirements of equipment manufacturer and, when required by Architect, obtain from equipment manufacturer, approval of foundation design and construction, for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a structural member so as to be readily removable.

**3.03 EQUIPMENT DESIGN AND INSTALLATION**

- A. Uniformity: Unless otherwise specified, equipment of same type or classification shall be product of same manufacturer.
- B. Application: Only provide equipment as reviewed by Architect.
- C. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed. Piping shall be installed in such a manner as not to place a strain on equipment. Flanged joints shall be adequately extended before installation. Piping shall be graded, anchored, guided and supported, without low pockets.
  - 1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.
  - 2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils, compressors and fan wheels. Access doors shall be hinged with cam lock door handles.
  - 3. Provide flexible connections for duct, pipe and conduit connections at moving equipment.

**3.04 ROOF-TOP EQUIPMENT MOUNTING**

- A. Downflow Packaged Units: Install unit on a prefabricated mounting frame or curb secured directly to roof. Follow manufacturers recommended installation manuals. Submit Shop Drawings for review by Architect.
- B. Horizontal Flow Packaged Units: Install unit on platform or prefabricated mounting frame or curb secured directly to roof designed to suit roof conditions and requirements of provided unit. Submit Shop Drawings for review by Architect.

**3.05 NOISE AND VIBRATION**

- A. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.
- B. Corrective Measures: If specified noise and/or vibration levels are exceeded, provide necessary changes to reduce noise and/or vibration levels to within specified levels.

**3.06 FIELD TESTS AND INSPECTION**

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- A. General: Perform field inspections, field tests, and trial operations as specified in Section 23 0500: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 0500: Common Work Results for HVAC.
- B. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.
- C. Start-Up and Operational Test: System shall be started up and initially operated with components operating. During this test, various strainers or filters shall be periodically cleaned until no further accumulation of foreign material occurs. Adjust safety and automatic control instruments as required to provide proper operation and control sequence. Refer to Section 23 0500: Common Work Results for HVAC.
- D. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 0500: Common Work Results for HVAC.
- E. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 0500: Common Work Results for HVAC.

**3.07 REFRIGERANT PIPING**

- A. Unless otherwise indicated, main liquid and suction lines from condensing unit to evaporator coil shall be of sizes specified by manufacturer.
- B. Refrigeration piping shall be refrigeration grade copper tubing, type L hard-drawn. In instances where refrigeration lines are installed in an inaccessible location and must be snaked through conduit or a trench, that portion of tubing required to complete connections through conduit or trench may be soft drawn. Maintain entire system clean and dry during installation. Pipe shall be sealed until installed.
- C. Refrigeration piping, both hard and soft-drawn, shall be straight and free from kinks, restrictions and horizontal runs shall be sloped towards compressor one inch to 10 feet wherever possible. Vapor line oil traps shall be installed on bottom of vertical risers and inverted oil trap shall be installed on top of vertical risers.
- D. Joints shall be installed with Sil-Fos 15, Silvaloy 15, or equal.
- E. Flare nuts required on suction lines shall be of short forged or frost-proof type. Other fittings shall be standard sweat-soldered type. Ells and return bends shall be long radius type. Install leak lock material.
- F. Refrigeration Piping: Joints shall be silver brazed and leak tested. Field fabricated lines shall be thoroughly flushed and cleaned before connection. Bleed nitrogen through lines during silver brazing, and cap and seal lines when not completed and connected to equipment.
- G. Sleeve penetrations of floors, walls and ceiling to allow for free motion of piping. Provide 24 gage galvanized iron pipe and chrome-plated escutcheon plates. Pack annular space between pipe and sleeve with incombustible material such as fiberglass and seal each end with mastic to provide a waterproof seal.
- H. Install insulated couplings at points of connection between dissimilar metals for cathodic protection. Insulate copper tubing from ferrous materials and hangers with 2-inch thickness of 3-inch wide strip, 10 mil polyvinyl tape wrapped around pipe.

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- I. Support piping by iron hangers and supports. Hydra-Zorb cushion clamps, LSP Products Group Acousto Clamp, or equal, on non-insulated piping, and Klo-Shure coupling clamp on insulated piping, or equal.
- J. Provide saddles to protect pipe insulation.
- K. Provide connections of copper, copper plated steel, steel, and brass pipe and tubing with Harris Products Group Safety-Silv 56, Lucas-Milhaupt, Inc., or equal, complying with ANSI/AWS A5.8 and NSF 51.
- L. Insulate refrigerant suction lines.
- M. On split heat pump systems, insulate both vapor and liquid lines. For insulation materials, refer to Section 23 0700: HVAC Insulation.

**3.08 CLEANUP**

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.

**3.09 PROTECTION**

- A. Protect Work of this Section until Substantial Completion.

**END OF SECTION**

## SECTION 23 8100 - FLOOR AND WALL MOUNTED HEAT PUMPS

### PART 1 – GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Floor and wall mounted heat pumps.
- B. Related Requirements:
  - 1. Division 01: General Requirements.
  - 2. Division 26: Electrical.
  - 3. Section 07 2100: Thermal Insulation.
  - 4. Section 22 1000: Plumbing.
  - 5. Section 23 0500: Common Work Results for HVAC.
  - 6. Section 23 0513: Basic HVAC Materials and Methods.
  - 7. Section 23 0548: HVAC Sound, Vibration and Seismic Control.
  - 8. Section 23 0900: HVAC Instrumentation and Controls.
  - 9. Section 23 0923: Environmental Control and Energy Management Systems.
  - 10. Section 23 2013: HVAC Piping.
  - 11. Section 23 3000: Air Distribution.

#### 1.02 SUBMITTALS

- A. Provide in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.

#### 1.03 QUALITY ASSURANCE

- A. Design, construction, testing and installation shall comply with the following standards as applicable:
  - 1. UL or ETL.
  - 2. ANSI/AHRI Standard 390.
  - 3. ASHRAE/IESNA 90.1.

#### 1.04 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 0500: Common Work Results for HVAC.

#### 1.05 WARRANTY

- A. Compressors shall carry unconditional five year warranty.

### PART 2 – PRODUCTS

#### 2.01 EQUIPMENT

- A. Capacities of heat pumps as indicated on Drawings are net capacities actually required. Standard catalog ratings shall be adjusted to actual Project site environmental conditions.

#### 2.02 FLOOR MOUNTED HEAT PUMPS

- A. Low noise, high efficiency, single packaged, indoor, floor mounted heat pump unit, Airedale, or equal.
  - 1. Sound Level: The unit shall operate at full load conditions with a maximum sound level of 45 dBA measured at five feet in front of the unit and five feet above the floor.
  - 2. Energy Efficiency:

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- a. Units less than 65,000 Btu/h: Minimum 13 SEER.
  - b. Units greater than or equal to 65,000 Btu/h and less than 135,000 Btu/h: Minimum 11.2 EER.
  - c. Units greater than or equal to 135,000 Btu/h and less than 240,000 Btu/h: Minimum 11.0 EER
  - d. Units greater than or equal to 240,000 Btu/h and less than 760,000 Btu/h: Minimum 10 EER
  - e. Units greater than or equal to 760,000: Minimum 9.7 EER.
3. Refrigerant: R-410A.
- B. Cabinet:
  1. Cabinet shall be constructed from galvanized sheet steel. After assembly cabinet shall be degreased and coated with a dry powder, epoxy resin paint, baked after application. Paint finish shall be easily cleanable and hard wearing to give maximum protection.
  2. Cabinet shall be insulated with acoustic foam insulation containing no fibrous materials. Foam insulation shall have a fire rating of UL 94 HF-1.
  3. The front of the unit shall contain a low-level return air grille integral to the front of the doors and a sound attenuating inlet plenum. Doors shall be hinged with a spring-loaded pin to allow for easy removal if required. Doors shall be secured with a key lock.
  4. The rear of the unit shall allow for high sill outside air discharge (up to 38 inches). A condensate connection stub shall also be provided internally at the rear of the unit for connection to the field installed building condensate drain.
  5. A vibration absorbing rubber mat shall be provided with each unit sized to fit exactly underneath the unit cabinet.
- C. Evaporator Fan: The indoor fan assembly shall consist of two blowers and one common shafted electronically commutated motor (ECM). The ECM motor shall have a wide range of programmable speed and torque characteristics for ultra high efficiency and low audible noise. The ECM motor shall also be fully programmed to compensate for a wide variety of static pressures as well as lack of maintenance (dirty air filters).
- D. Condenser Fan: The outdoor fan assembly shall consist of two backward curved plug fans with centrifugal blower wheels. The fans and fan motor shall be mounted on a fan board. The fan board shall be easily removable from the front of the cabinet so as to allow quick replacement of the entire assembly. The fan board shall be rubber mounted to the cabinet.
- E. Compressor: The refrigeration system shall contain a two stage hermetic scroll compressor equipped with a crankcase heater to guard against liquid floodback conditions and the elimination of oil foaming upon start up. The compressor shall contain an internal unloading mechanism, providing capacity control and enabling part load efficiencies to be increased. An internal overload protector shall protect the compressor against excessive motor temperatures and currents. The compressor shall also be mounted on vibration absorbers for quiet operation and be fully encased in a precisely fitted, sand filled acoustic cover. The cover shall feature fasteners so as to permit easy removal for compressor servicing.

- F. Evaporator: Quick draining, hydrophilic fin, evaporator coils of non-ferrous construction with enhanced louvered aluminum fins mechanically bonded to grooved copper tubes, and factory tested.
- G. Condenser: The unit shall contain an enhanced, high efficiency, cross-rifle tube condenser coil. Coils shall be of non-ferrous construction with enhanced louvered aluminum fins mechanically bonded to grooved copper tubes, and factory tested.
- H. Drain Pans: Non-corrosive drain pans sloped for positive drainage at both indoor and outdoor coils.
- I. Expansion Valves: Thermostatic Expansion Valves with removable power head.
- J. Refrigerant Filters: Bi-flow filter drier.
- K. Air Filters: 2-inch disposable filters of MERV 8 efficiency with a separate filter access door.
- L. Outdoor Air Intake: Shall have outside air make-up for ventilation mixed with return air, filtered through the same filter, prior to passing through evaporator coil. The outside air shall not by-pass evaporator. Outside air ventilation damper shall automatically adjust to set OSA CFM during any operation mode, ventilation, 1<sup>st</sup> stage or 2<sup>nd</sup> stage, and fully close during unoccupied modes.
- M. Economizer: Each unit shall be fitted with a spring return modulating damper that acts to mix the outdoor air with the return air. The damper shall have the capability of permitting only the outside air into the space, or recycling the return air and allowing only a minimum of outside air to enter the space. Full modulation allowing any mixture of outside air and return air shall be possible. A minimum damper position setting shall also be possible to continuously maintain outside air ventilation requirements dependent on control via the unit's microprocessor controller.
- N. Powered Exhaust: Powered exhaust shall be integral to the unit to prevent over pressurization of the space with the exhaust fan capable of exhausting 100 percent of room air.
- O. Controls: Unit shall be fitted with a programmable microprocessor controller mounted outside the air stream and specifically designed to operate the unit in an energy efficient manner using pre-engineered control strategies. The microprocessor shall determine mode of operation based on the return air, supply air, and ambient air temperatures. The microprocessor controller shall be capable of managing the unit in each of the following modes of operation:
  - 1. Cooling Operation:
    - a. Stage One Cooling: 67 percent capacity compressor, low speed fan.
    - b. Stage Two Cooling: 100 percent capacity compressor, low speed fan.
    - c. Stage Three Cooling: 100 percent capacity compressor, high speed fan.
  - 2. Heating Operation:
    - a. Stage One Heating: 67 percent capacity compressor, low speed supply fan.
    - b. Stage Two Heating: 100 percent capacity compressor, high speed supply fan.
  - 3. The microprocessor controller shall also modify the minimum damper position to compensate for mode of operation and fan speed.
- P. Disconnect Switch: The unit shall be fitted with a power disconnect switch located on the control panel and sized for the full load amperage of the unit. In the off position

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the switch can be locked out. The handle for the disconnect switch shall be flush mounted on the control panel lid.

- Q. Thermostat: A temperature sensor and set point adjustment module with occupied override button shall be mounted either internally or externally on the unit.
- R. Timer: A rotary dial time clock allowing up to six hours occupied operation shall be mounted on the front door of the unit.
- S. Electrical: 480V 3 phase, 208-230V 3 phase, or 208-230V 1 phase as indicated on the drawings. Contractor shall verify available power on site before ordering equipment.
- T. Mounting: Manufacturer shall provided DSA approved mounting details and hardware.
- U. Factory Testing: Every unit shall be factory run tested and certified as being successfully tested before shipping.
- V. Start-up and Training: Provide start-up and customer training for the supplied equipment. Start-up will be coordinated with the local representative.
- W. Accessories:

- 1. Duct Shroud: The 26-inch or 38-inch three sided duct shroud shall be painted to match the unit and shall extend from the top of the unit through the ceiling. The shroud shall be trimmed in the field by the mechanical contractor to suit the ceiling height.
- 2. Acoustic Plenum: A plenum/box with top discharge shall be mounted on top of the unit. The plenum shall be lined with acoustic foam to minimize noise levels. The plenum shall be available in heights from 24 inches to 30 inches in 2-inch increments. The plenum shall be field mounted, provide all required hardware.
- 3. Outdoor Coil Filter: A wire framed synthetic filter shall be fitted across the inlet of the outdoor coils. This shall be reusable and may be vacuum cleaned.
- 4. Outdoor Louver: Provide outdoor louver when indicated on the drawings. Louver shall be suitable for masonry, glass, or panel wall construction. The louvers shall be provided available in the following materials and may be flanged or recessed style with bird screens. Verify with Architect for specific requirements:

a. Style: [Flanged] [recessed].

b. Finish: Standard

- 5. Wall Sleeve: Wall sleeve shall be constructed from galvanized steel. An interior separator plate running the entire length of the sleeve shall separate the fresh air inlet from the exhaust air. The sleeve shall be provided by manufacturer and insulated by the installing contractor with foil back insulation.

## 2.03 WALL MOUNTED HEAT PUMPS

- A. Low noise, high efficiency, single packaged, outdoor, wall mounted heat pump unit, Bard, or equal.
  - 1. Sound Level: The system, including acoustical supply and return plenums, shall operate in an unoccupied room at a sound level of 45 dBA at a distance of five feet in front of unit and five above the floor.

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2. Energy Efficiency:
    - a. Units less than 65,000 Btu/h: Minimum 13 SEER.
    - b. Units greater or equal to 65,000 Btu/h and less than 135,000 Btu/h: Minimum 11.2 EER.
    - c. Units greater or equal to 135,000 Btu/h and less than 240,000 Btu/h: Minimum 11.0 EER
    - d. Units greater or equal to 240,000 Btu/h and less than 760,000 Btu/h: Minimum 10 EER
    - e. Units greater or equal to 760,000: Minimum 9.7 EER.
  3. Refrigerant: R-410A.
- B. Cabinet: Galvanized 20 gage zinc coated steel with minimum 14 gage steel frame. Cabinet shall be cleaned, rinsed, sealed, dried and primed with polyurethane primer and finished with a baked on textured enamel. Cabinet shall withstand 1000 hours of salt spray tests per ASTM B117. Provide front or top supply air discharge as indicated on the drawings.
  - C. Evaporator Fan: Forward curved centrifugal twin blower wheels with a high efficiency ECM direct drive, variable speed motor. Motor shall have permanently lubricated bearings.
  - D. Condenser Fan: Propeller fan with single speed motor. The outdoor motor and shroud assembly shall slide out for easy access.
  - E. Compressor: Hermetically sealed two stage scroll compressor mounted on isolation rails with double grommets and an insulated sound cover. The two stage compressors cooling/heating system shall be capable of changing stages while running without shutting the compressor off. The compressor shall include built-in thermal and current overload protection. A current sensing relay shall be included to detect high compressor amps due to low voltage and high ambient temperatures, and drop compressor to first stage keeping the compressor on-line until the low voltage condition is corrected. Three phase units shall be provided with a built-in phase monitor device to prevent reverse rotation of scroll compressor motor.
  - F. Evaporator: Coils shall be of non-ferrous construction with enhanced louvered aluminum fins mechanically bonded to grooved copper tubes, and factory tested.
  - G. Condenser: Coils shall be of non-ferrous construction with enhanced louvered aluminum fins mechanically bonded to grooved copper tubes, and factory tested. The outdoor coil shall be draw through and discharge horizontally out both sides of the unit.
  - H. Drain Pans: Stainless steel drain pans sloped for positive drainage at both indoor and outdoor coils.
  - I. Expansion Valves: Thermostatic Expansion Valves with fixed power head.
  - J. Refrigerant Filters: Bi-flow filter drier.
  - K. Filters: 2-inch disposable filters of MERV 8 efficiency with a separate filter access door.
  - L. Outdoor Air Intake: Shall have outside air make-up for ventilation mixed with return air, filtered through the same filter, prior to passing through evaporator coil. The outside air shall not by-pass evaporator. Outside air ventilation damper shall automatically adjust to set OSA CFM during any operation mode, ventilation, first stage or second stage, and fully close during unoccupied modes. OSA shall be factory set for 450 CFM.

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- M. Safety Controls: High and Low pressure switches shall be provided with a built in lock out circuit that resets from the room thermostat. The controls shall include a low pressure bypass time delay to prevent nuisance tripping of the low pressure control.
- N. Operating Controls: Shall have controls to automatically operate the mechanical equipment through the heating or cooling and ventilating cycles as required.
- O. Electrical Power: 480V 3 phase, 208-230V 3 phase, or 208-230V 1 phase as indicated on the drawings. Contractor shall verify available power on site before ordering equipment.
- P. Mounting: As indicated in the drawings.
- Q. Factory Testing: Every unit shall be factory run tested and certified as being successfully tested before shipping.
- R. Accessories: Provide the following accessories:
  - 1. Indoor supply and return air acoustical plenums.
  - 2. Exterior sound isolation curb.
  - 3. Expanded metal mesh outdoor coil guard, minimum 13 gage.

### **PART 3 – EXECUTION**

#### **3.01 GENERAL**

- A. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.

#### **3.02 EQUIPMENT FOUNDATIONS**

- A. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under any abnormal conditions imposed upon equipment.
- B. Foundations shall meet requirements of equipment manufacturer and, when required by Architect, obtain from equipment manufacturer, approval of foundation design and construction, for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a structural member so as to be readily removable.

#### **3.03 EQUIPMENT DESIGN AND INSTALLATION**

- A. Uniformity: Unless otherwise specified, equipment of same type or classification shall be product of same manufacturer.
- B. Application: Only provide equipment as reviewed by Architect.
- C. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed. Piping shall be installed in such a manner as not to place a strain on any of equipment. Flanged joints shall be adequately extended before installation. Piping shall be graded, anchored, guided and supported, without low pockets.
  - 1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.
  - 2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils,

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compressors and fan wheels. Access doors shall be hinged with cam lock door handles.

3. Provide flexible connections for duct, pipe and conduit connections at moving equipment.

**3.04 NOISE AND VIBRATION**

- A. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.
- B. Corrective Measures: If specified noise and/or vibration levels are exceeded, the installing HVAC contractor must provide necessary changes to reduce noise and/or vibration levels to within specified levels.

**3.05 FIELD TESTS AND INSPECTION**

- A. General: Perform field inspections, field tests, and trial operations as specified in Section 23 0500: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 0500: Common Work Results for HVAC.
- B. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.
- C. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 0500: Common Work Results for HVAC.
  1. TAB (Test and Balance) and sound level measurement according to SMACNA and ANSI Standard S12.6, respectively, will be performed by a District approved agency. Noise level generated by the HVAC unit measured 5 feet from the unit shall not exceed 45 dBA.
- D. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 0500: Common Work Results for HVAC.

**3.06 CONDENSATE DRAIN LINE PIPING**

- A. Sleeve penetrations of floors, walls and ceiling to allow for free motion of piping. Provide type L copper pipe and 24 gage chrome-plated escutcheon plates. Pack annular space between pipe and sleeve with incombustible material such as fiberglass and seal each end with mastic to provide a waterproof seal.

**3.07 CLEANUP**

- A. Remove rubbish, debris and waste materials and legally dispose of off Project site.

**3.08 PROTECTION**

- A. Protect Work of this Section until Substantial Completion.

**END OF SECTION**

**238129 - VARIABLE REFRIGERANT VOLUME HVAC SYSTEM**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

A. Variable refrigerant volume HVAC system includes:

1. Outdoor/Condensing unit(s):

a. Size Range: 6 to 40 Tons Nominal

b. Daikin Model Numbers:

REYQ72AATJ\*

REYQ96AATJ\*

REYQ120AATJ\*

REYQ144AATJ\*

REYQ168AATJ\*

REYQ192AATJ\*

REYQ216AATJ\*

REYQ240AATJ\*

REYQ264AATJ\* (REYQ144AATJ\* + REYQ120AATJ\*)

REYQ288AATJ\* (REYQ144AATJ\* + REYQ144AATJ\*)

REYQ312AATJ\* (REYQ168AATJ\* + REYQ144AATJ\*)

REYQ336AATJ\* (REYQ168AATJ\* + REYQ168AATJ\*)

REYQ360AATJ\* (REYQ168AATJ\* + REYQ192AATJ\*)

REYQ384AATJ\* (REYQ192AATJ\* + REYQ192AATJ\*)

REYQ408AATJ\* (REYQ192AATJ\* + REYQ216AATJ\*)

REYQ432AATJ\* (REYQ216AATJ\* + REYQ216AATJ\*)

REYQ456AATJ\* (REYQ216AATJ\* + REYQ240AATJ\*)

REYQ480AATJ\* (REYQ240AATJ\* + REYQ240AATJ\*)

2. Branch Selector Boxes

a. *\*Input information as required*

3. Indoor Units

a. *\*Input information as required*

**1.02 RELATED REQUIREMENTS**

A. N/A

**1.03 REFERENCES**

A. N/A

**1.04 SUBMITTALS**

A. N/A

**1.05 QUALITY ASSURANCE**

A. MANUFACTURER QUALIFICATIONS:

1. The units shall be tested by a National Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

2. All wiring shall be in accordance with the National Electric Code (NEC).

3. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

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4. The condensing unit will be factory charged with R410A.

### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendations.

### 1.07 WARRANTY

#### A. STANDARD LIMITED WARRANTY

1. Complete warranty details available from your local Daikin representative or at [www.daikincomfort.com](http://www.daikincomfort.com).
2. Daikin North America LLC warrants original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the "installation date" which is one of the two dates below:
  - a. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.
  - b. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

#### A. DESIGN BASIS:

1. The HVAC equipment basis of design is Daikin North America. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Appendix A HVAC Equipment Alternate General Information). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

### 2.02 HVAC SYSTEM DESIGN

#### A. SYSTEM DESCRIPTION:

1. The variable capacity heat recovery air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat or cool model) system as specified.
2. The system shall consist of multiple evaporators, branch selector boxes, REFNET™ joints and headers, a three-pipe refrigeration distribution system using PID control and Daikin VRV<sup>a</sup> condenser unit.
3. The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.
4. The condensing unit may connect an indoor evaporator nominal capacity up to 200% of the condensing unit nominal capacity. All zones are each capable of operating separately with individual temperature control.
5. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance.
  - a. Two-pipe, heat recovery systems utilizing a lower temperature mixed liquid/gas refrigerant to perform heat recovery are not acceptable due to reduced heating capabilities.

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6. The Daikin condensing unit shall be able to connect to indoor unit models CXTQ, FXFQ, FXHQ, FXMQ, FXLQ, FXNQ, FXSQ, FXTQ, FXDQ, FXZQ, FXUQ, FXEQ, FXAQ and FXMQ\_MF, and shall range in capacity from 5,800 Btu/h to 96,000 Btu/h in accordance with Daikin's engineering data book detailing each available indoor unit.
  - a. The indoor units shall be connected to the condensing unit utilizing Daikin's REFNET™ specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable for a variable refrigerant system.
7. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box (BSQ\_T / BS\_Q54T / BSF\_Q54T). Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.
8. Branch selector boxes:
  - a. The branch selector boxes shall have the capacity to control up to 290 MBH (cooling) downstream of the branch selector box.
  - b. Each branch of the branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units.
  - c. The branch selector box shall control the operational mode of the subordinate indoor units. The use of three EEV's ensures continuous heating during defrost (multiple condenser systems), no heating impact during changeover and reduced sound levels.
  - d. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
9. The REYQ\_AA condensing unit model numbers and the associated number of connectable indoor units per REYQ\_AA condensing unit is indicated in the following table. Each indoor unit or group of indoor units shall be independently controlled.

MODEL NUMBER	NOMINAL CAPACITY (Tons)	MAXIMUM NUMBER OF INDOOR UNITS
REYQ72AATJ*	6	12
REYQ96AATJ*	8	16
REYQ120AATJ*	10	20
REYQ144AATJ*	12	25
REYQ168AATJ*	14	29
REYQ192AATJ*	16	33
REYQ216AATJ*	18	37
REYQ240AATJ*	20	41
REYQ264AATJ*	22	45
REYQ288AATJ*	24	49
REYQ312AATJ*	26	54
REYQ336AATJ*	28	58
REYQ360AATJ*	30	64
REYQ384AATJ*	32	64
REYQ408AATJ*	34	64

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REYQ432AATJ*	36	64
REYQ456AATJ*	38	64
REYQ480AATJ*	40	64

**B. VRV EMERION FEATURES AND BENEFITS**

1. Voltage Platform - The condensing units shall be available with a 208-230V/3ph/60 Hz power supply.
2. Single-module outdoor units shall be available from 6 to 20 T in nominal cooling capacity and can be combined to offer up to 40 T in a dual-module configuration, which helps minimize the overall space required for mechanical equipment and optimize total project costs.
3. The condensing unit shall feature a sealed E-box with a minimum of IP55 rating to provide high dust and moisture protection for reliability
4. Gas Furnace Connectivity – Heat Pump condensing units shall be connectable to Daikin Communicating gas furnaces with AFUE ranging from 80% to 97%.
5. System shall be capable of connecting to multiple VRV A-coils (CXTQ) paired with Daikin Communicating gas furnaces allowing for options of gas or heat pump heating to optimize operational costs based on changing utility costs.
6. The system shall be able to switch between heat pump heating and gas furnace heating at a field selectable change-over temperature which can be configured via condensing unit field settings.
7. Each system shall be able to enlarge from single to dual module without the need for installed main pipe size changes. The manufacturer shall provide predefined pipe sizes and design rules ensuring reliable system operation and offering design flexibility in phased installation applications.
8. Stable Operation – System shall provide stable inverter operation at varied ambient conditions.
9. No Drain Pan Heater – System shall be capable of heating operation without the need for a drain pan heater. If alternate manufacturer is chosen, an additional drain pan heater shall be provided by the manufacturer.
10. Auto Changeover – System shall, below the field selected outdoor ambient temperature provide signal to initiate auxiliary or back up heat.
11. Advanced Zoning - A single system shall provide for up to 64 zones.
12. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve with up to 2000 positions for independent control.
13. VFD Inverter Control and Variable Refrigerant Temperature - Each condensing unit shall use high efficiency, variable speed all “inverter” based flash vapor injection compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.
  - a. Indoor shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.

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14. Configurator software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.
  - a. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.
15. Each system shall include a built-in data recorder that can store up to 45 minutes of operational data which can help identify the issue in case of a product failure
16. Heating during Defrost and Oil Return– 16 T and above VRV systems shall maintain continuous heating during defrost and oil return operation. Reverse cycle (cooling mode) in these modes shall not be permitted due to the potential reduction in space temperature.
17. Low Ambient Cooling - Each system shall be capable of low ambient cooling operation to -4°FDB (-20°CDB).
18. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve for independent control.
19. Flexible Design –
  - a. Systems shall be capable of up to 540ft (165m) [623 ft. (190m) equivalent] of linear piping between the condensing unit and furthest located indoor unit.
  - b. Systems shall be capable of up to 3,280ft (1,000m) total “one-way” piping in the piping network.
  - c. Systems shall have a vertical (height) separation of up to 361 ft between the condensing unit and the indoor units.
  - d. Systems shall be capable of up to 295ft (90m) from the first REFNET™ / branch point.
  - e. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit nominal capacity.
  - f. Systems shall be capable of 98ft (30m) vertical separation between indoor units.
  - g. Condensing units shall be supported with a fan motor ESP up to 0.32” WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.
20. Oil return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.
21. Simple wiring – Systems shall use 16/18 AWG, 2 wire, stranded, non-shielded and non-polarized daisy chain control wiring.
22. Space saving – Each system shall not exceed the dimensions shown below

MODEL NUMBER	Dimensions in Inch (H x W x D)
REYQ72AATJ*	65-3/8 x 36-5/8 x 30-1/8
REYQ96AATJ*	65-3/8 x 48-13/16 x 30-1/8
REYQ120AATJ*	
REYQ144AATJ*	
REYQ168AATJ*	
REYQ192AATJ*	65-3/8 x 68-7/8 x 30-1/8
REYQ216AATJ*	
REYQ240AATJ*	

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REYQ264AATJ*	(65-3/8 x 48-13/16 x 30-1/8) + (65-3/8 x 48-13/16 x 30-1/8)
REYQ288AATJ*	
REYQ312AATJ*	
REYQ336AATJ*	
REYQ360AATJ*	(65-3/8 x 48-13/16 x 30-1/8) + (65-3/8 x 68-7/8 x 30-1/8)
REYQ384AATJ*	(65-3/8 x 68-7/8 x 30-1/8) + (65-3/8 x 68-7/8 x 30-1/8)
REYQ408AATJ*	
REYQ432AATJ*	
REYQ456AATJ*	
REYQ480AATJ*	

23. Each condensing unit shall include a multi-functional digital display that can provide system operation status such as operating refrigerant temperatures, pressures, outdoor electronic expansion valve opening and compressor operation time.
24. Each condensing unit shall include a service window that can provide easy access to system field settings and operation status without completely removing the condensing unit panel.
25. Advanced diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.
26. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.
27. Advanced controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.
28. Each system shall be capable of integrating with open protocol BACnet, LonWorks and Modbus building management systems.
29. Low sound levels - Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).
30. The system shall be certified and listed in OSHPD directory for seismic certification
31. The condensing unit can be installed up to 200 ft above the ground without requiring any additional field modifications to the unit to comply with the Florida Miami Dade Wind code requirements.
32. The condensing unit shall be factory equipped with a Schrader valve for connection to a pressure relief kit for compliance with City of Chicago Pressure relief code.

**C. PERFORMANCE:**

1. The VRV REYQ\_AA system shall perform as indicated below:

<b>MODEL NUMBER</b>	<b>SYSTEM IEER (Ducted)</b>	<b>SYSTEM IEER (Non-Ducted)</b>
REYQ72AATJ*	23.00	28.00
REYQ96AATJ*	25.30	30.00
REYQ120AATJ*	23.50	27.50
REYQ144AATJ*	22.50	26.50
REYQ168AATJ*	21.40	24.00
REYQ192AATJ*	21.00	24.00

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REYQ216AATJ*	20.50	23.00
REYQ240AATJ*	19.70	21.60
REYQ264AATJ*	19.20	23.90
REYQ288AATJ*	19.30	23.20
REYQ312AATJ*	19.20	22.80
REYQ336AATJ*	18.60	22.10
REYQ360AATJ*	18.20	21.00
REYQ384AATJ*	18.80	22.00
REYQ408AATJ*	18.40	21.50
REYQ432AATJ*	18.10	21.10
REYQ456AATJ*	17.50	20.20
REYQ480AATJ*	17.20	19.40

MODEL NUMBER	SYSTEM SCHE (Ducted)	SYSTEM SCHE (Non-Ducted)
REYQ72AATJ*	22.00	26.10
REYQ96AATJ*	21.10	26.10
REYQ120AATJ*	22.20	26.10
REYQ144AATJ*	22.10	25.60
REYQ168AATJ*	22.30	25.60
REYQ192AATJ*	22.80	26.60
REYQ216AATJ*	21.90	25.50
REYQ240AATJ*	21.80	25.60
REYQ264AATJ*	18.20	26.20
REYQ288AATJ*	20.00	23.40
REYQ312AATJ*	20.80	24.40
REYQ336AATJ*	19.80	23.40
REYQ360AATJ*	19.40	23.00
REYQ384AATJ*	17.00	22.00
REYQ408AATJ*	18.40	21.90
REYQ432AATJ*	18.20	20.30
REYQ456AATJ*	18.00	18.90
REYQ480AATJ*	16.50	16.90

MODEL NUMBER	SYSTEM EER (Ducted)	SYSTEM EER (Non-Ducted)
REYQ72AATJ*	12.80	15.70
REYQ96AATJ*	12.80	14.60
REYQ120AATJ*	12.40	13.20
REYQ144AATJ*	12.00	12.50
REYQ168AATJ*	11.10	11.50

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REYQ192AATJ*	11.50	12.30
REYQ216AATJ*	11.00	11.50
REYQ240AATJ*	10.80	11.00
REYQ264AATJ*	10.60	12.00
REYQ288AATJ*	11.00	12.00
REYQ312AATJ*	10.80	11.30
REYQ336AATJ*	10.60	10.50
REYQ360AATJ*	10.70	11.50
REYQ384AATJ*	10.50	10.70
REYQ408AATJ*	10.50	10.70
REYQ432AATJ*	10.10	10.70
REYQ456AATJ*	9.80	9.90
REYQ480AATJ*	9.60	9.70

<b>MODEL NUMBER</b>	<b>SYSTEM COP@47°F (Ducted)</b>	<b>SYSTEM COP@47°F (Non-Ducted)</b>
REYQ72AATJ*	3.58	4.35
REYQ96AATJ*	3.56	4.30
REYQ120AATJ*	3.48	4.00
REYQ144AATJ*	3.35	3.80
REYQ168AATJ*	3.20	3.50
REYQ192AATJ*	3.45	3.85
REYQ216AATJ*	3.25	3.70
REYQ240AATJ*	3.20	3.45
REYQ264AATJ*	3.20	3.70
REYQ288AATJ*	3.27	3.60
REYQ312AATJ*	3.25	3.60
REYQ336AATJ*	3.23	3.60
REYQ360AATJ*	3.21	3.60
REYQ384AATJ*	3.25	3.40
REYQ408AATJ*	3.25	3.40
REYQ432AATJ*	3.25	3.40
REYQ456AATJ*	3.25	3.40
REYQ480AATJ*	3.25	3.40

<b>MODEL NUMBER</b>	<b>SYSTEM COP@17°F (Ducted)</b>	<b>SYSTEM COP@17°F (Non-Ducted)</b>
REYQ72AATJ*	2.40	2.50
REYQ96AATJ*	2.25	2.48
REYQ120AATJ*	2.25	2.38
REYQ144AATJ*	2.10	2.20

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REYQ168AATJ*	2.10	2.10
REYQ192AATJ*	2.05	2.05
REYQ216AATJ*	2.05	2.05
REYQ240AATJ*	2.05	2.05
REYQ264AATJ*	2.10	2.35
REYQ288AATJ*	2.13	2.41
REYQ312AATJ*	2.10	2.35
REYQ336AATJ*	2.10	2.20
REYQ360AATJ*	2.05	2.05
REYQ384AATJ*	2.05	2.05
REYQ408AATJ*	2.05	2.05
REYQ432AATJ*	2.05	2.05
REYQ456AATJ*	2.05	2.05
REYQ480AATJ*	2.05	2.05

## 1. Performance Conditions:

- a. Cooling: Indoor temperature of 80°FDB (26.7°CDB), 67°FWB (19.5°CWB) and outdoor temperature of 95°FDB (35°CDB).
- b. Heating: Indoor temperature of 70°FDB (21.1°CDB) and outdoor temperature of 47°FDB (8.3°CDB), 43°FWB (6.1°CDB).
- c. Equivalent piping length: 25ft (7.5m)

## 2. Cooling or Cooling Dominant Operation:

- a. The standard operating range in cooling or cooling dominant simultaneous cooling/heating will be 23°FDB (-5°CDB) ~ 122°FDB (50°CDB).
- b. Cooling mode indoor room temperature range will be 57-77°FWB (13.8 - 25°CWB).
- c. Each system as standard shall be capable of onsite reprogramming to allow low ambient cooling operation down to -4°FDB (-20°CDB).

## 3. Heating or Heating Dominant Operation:

- a. The standard operating range in heating or heating dominant simultaneous cooling/heating will be -13° – 61°FWB (-25 – 16°CWB).
  - 1) If an alternate equipment manufacturer is selected, the mechanical contractor shall provide, at their own risk and cost, all additional material and labor to meet low ambient operating condition and performance
- b. Heating mode indoor room temperature range will be 59°FDB - 80°F DB (15°CDB – 26.7°CDB).

**2.03 EQUIPMENT**

## A. ELECTRICAL:

1. The power supply to the condensing unit shall be:

POWER SUPPLY VOLTAGE	VOLTAGE RANGE
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208-230V / 3ph / 60 Hz		187V – 253V (±10%)
MODEL	MCA	MOP
REYQ72AATJ*	27.3 A	30 A
REYQ96AATJ*	34.1 A	35 A
REYQ120AATJ*	36.5 A	40 A
REYQ144AATJ*	47.8 A	50 A
REYQ168AATJ*	54.9 A	60 A
REYQ192AATJ*	59.8 A	60 A
REYQ216AATJ*	67.2 A	70 A
REYQ240AATJ*	73.7 A	80 A
REYQ264AATJ*	36.5+47.8 A	40+50 A
REYQ288AATJ*	47.8+47.8 A	50+50 A
REYQ312AATJ*	47.8+54.9 A	50+60 A
REYQ336AATJ*	54.9+54.9 A	60+60 A
REYQ360AATJ*	54.9+59.8 A	60+60 A
REYQ384AATJ*	59.8+59.8 A	60+60 A
REYQ408AATJ*	59.8+67.2 A	60+70 A
REYQ432AATJ*	67.2+67.2 A	70+70 A
REYQ456AATJ*	67.2+73.7 A	70+80 A
REYQ480AATJ*	73.7+73.7	80 + 80 A

**B. WIRING:**

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.
3. The control wiring maximum lengths shall be as shown below:

	CONDENSER TO INDOOR UNIT	CONDENSER TO CENTRAL CONTROLLER	INDOOR UNIT TO REMOTE CONTROL
CONTROL WIRING LENGTH	6,560ft (2,000m)	3,280ft (1,000m)	1640 ft. (500m)
WIRE TYPE	16/18 AWG, 2 wire, non-polarity, non-shielded, stranded		

**C. REFRIGERANT PIPING:**

1. The system shall be capable of refrigerant piping up to 540ft (165m) actual or 623ft (190m) equivalent from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280ft (1,000m) of piping between the condensing and indoor units, without any oil traps or additional components.
2. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.

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- a. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

**D. PAINT/CORROSION RESISTANCE:**

1. Paint and corrosion resistance shall be at a minimum per the table below:

COMPONENT	VRV EMERION		
	BASE MATERIAL	SURFACE TREATMENT	COATING THICKNESS
			External & Internal Surface
EXTERNAL PANEL BASE	Galvanized steel	POLYESTER	≥1.5 mils
EXTERNAL FRONT PANEL	Galvanized steel	POLYESTER	≥1.5 mils
PILLAR	Galvanized steel	POLYESTER	≥1.5 mils
COMPRESSOR COVER	ASTM material	Resin Paint	≥0.78 mils
FIN GUARD	Iron wire	Resin Paint	≥0.79 mils
FAN GUARD AND DRUM	Polypropylene	No treatment required	N/A
FAN	Acrylonitrile - glass	No treatment required	N/A
FAN MOTOR FRAME	Resin	No treatment required	N/A
FAN MOTOR SHAFT	Carbon steel	No treatment required	N/A
FAN MOTOR SUPPORT	Galvanized steel	POLYESTER	≥1.5 mils
HEAT EXCHANGERS (FIN ONLY)	Aluminum	Polymer Anti-corrosion surface treatment	Salt Spray 1000 hours, blister rating 10
ELECTRICAL PARTS BOX	Hot-dip zinc-coated steel	No treatment required	N/A
ELECTRICAL PARTS BOARD	Glass cloth / Glass nonwoven cloth material	Insulation Varnish	No specific thickness
SCREWS	Carbon steel wire rods	High corrosion resistance treatment	≥0.28 mils

**2.04 OUTDOOR/CONDENSING UNIT****A. GENERAL:**

1. The condensing unit is designed specifically for use with VRV series components.
2. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves,

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4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.

3. High/Low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.
4. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
5. The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.
6. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.
7. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.
8. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
9. The condensing unit shall be modular in design and should allow for side-by-side installation.
10. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
11. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
12. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
13. The condensing unit shall be capable of heating operation at -13°F (-25°C) wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
14. 16 T and above VRV systems shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

### B. UNIT CABINET:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel finish.
2. Each condensing unit shall have a three-segment panel design which allows for direct access to outdoor fans, critical mechanical and electrical components separately for ease of installation and service.
3. Each outdoor unit shall have separate knock-outs for both refrigerant piping and wiring on the bottom panel

### FAN:

4. The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter. Reference table below.

MODEL NUMBER	FAN MOTOR OUTPUT (W) & QUANTITY
--------------	---------------------------------

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REYQ72AATJ*	950 x 1
REYQ96AATJ*	650 x 2
REYQ120AATJ*	650 x 2
REYQ144AATJ*	650 x 2
REYQ168AATJ*	650 x 2
REYQ192AATJ*	950 x 2
REYQ216AATJ*	950 x 2
REYQ240AATJ*	950 x 2
REYQ264AATJ*	(650 x 2) + (650 x 2)
REYQ288AATJ*	(650 x 2) + (650 x 2)
REYQ312AATJ*	(650 x 2) + (650 x 2)
REYQ336AATJ*	(650 x 2) + (650 x 2)
REYQ360AATJ*	(650 x 2) + (950 x 2)
REYQ384AATJ*	(950 x 2) + (950 x 2)
REYQ408AATJ*	(950 x 2) + (950 x 2)
REYQ432AATJ*	(950 x 2) + (950 x 2)
REYQ456AATJ*	(950 x 2) + (950 x 2)

5. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
  6. The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.
  7. Each outdoor unit fan shall be a vertical discharge configuration and the nominal airflow rate for each module will range from 6,200CFM to 14,505 CFM dependent on model specified.
  8. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
  9. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
- C. SOUND:
1. Nominal sound pressure levels shall be as shown below.

<b>MODEL NUMBER</b>	<b>SOUND PRESSURE LEVEL dB(A)</b>
REYQ72AATJ*	58 dBA
REYQ96AATJ*	61 dBA
REYQ120AATJ*	61 dBA
REYQ144AATJ*	65 dBA
REYQ168AATJ*	65 dBA
REYQ192AATJ*	67 dBA
REYQ216AATJ*	68 dBA
REYQ240AATJ*	69 dBA
REYQ264AATJ*	67 dBA
REYQ288AATJ*	69 dBA

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REYQ312AATJ*	69 dBA
REYQ336AATJ*	69 dBA
REYQ360AATJ*	70 dBA
REYQ384AATJ*	71 dBA
REYQ408AATJ*	71 dBA
REYQ432AATJ*	72 dBA
REYQ456AATJ*	72 dBA
REYQ480AATJ*	73 dBA

2. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

<b>OPERATION SOUND dB(A)</b>	<b>NIGHT MODE SOUND PRESSURE LEVEL dB(A) APPROX.</b>
Level 1	55
Level 2	50
Level 3	45

**D. CONDENSER COIL:**

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM B117 test standards.
5. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for a drain pan heater. The lower part of the coil shall be used for inverter cooling and be on or off during operation enhancing the defrost operation.
  - a. An alternate manufacturer must provide a drain pan heater to enable adequate defrosting of the unit in defrost operation.
6. The condensing unit shall be factory equipped with condenser coil guards on all sides.

**E. COMPRESSOR:**

1. The Daikin inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
  - a. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value.

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- 1) Non –inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “P-type”.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type.
  - a. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 1% to 100%.
5. The compressor’s motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
9. In the event of compressor failure, the remaining compressors, if applicable, shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be manually activated to specifically address this condition for single module and manifold systems.
10. In the case of multiple condenser modules, combined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.
11. Compressor configurations:

MODEL NUMBER	COMPRESSOR MOTOR OUTPUT (W)	QUANTITY	COMPRESSOR TYPES
REYQ72AATJ*	4390	1	Inverter controlled
REYQ96AATJ*	2740 + 2740	2	Inverter controlled
REYQ120AATJ*	3630 + 3630	2	Inverter controlled
REYQ144AATJ*	3360 + 5720	2	Inverter controlled
REYQ168AATJ*	4090 + 6960	2	Inverter controlled
REYQ192AATJ*	5820 + 5820	2	All inverter controlled
REYQ216AATJ*	6560 + 6560	2	All inverter controlled
REYQ240AATJ*	7580 + 7580	2	All inverter controlled
REYQ264AATJ*	(3630 + 3630) + (3360 + 5720)	4	All inverter controlled
REYQ288AATJ*	(3360 + 5720) + (3360 + 5720)	4	All inverter controlled
REYQ312AATJ*	(3360 + 5720) + (4090 + 6960)	4	All inverter controlled
REYQ336AATJ*	(4090 + 6960) + (4090 + 6960)	4	All inverter controlled
REYQ360AATJ*	(4090 + 6960) + (5820 + 5820)	4	All inverter controlled
REYQ384AATJ*	(5820 + 5820) + (5820 + 5820)	4	All inverter controlled

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REYQ408AATJ*	(5820 + 5820) + (6560 + 6560)	4	All inverter controlled
REYQ432AATJ*	(6560 + 6560) + (6560 + 6560)	4	All inverter controlled
REYQ456AATJ*	(6560 + 6560) + (7580 + 7580)	4	All inverter controlled
REYQ480AATJ*	(7580 + 7580) + (7580 + 7580)	4	All inverter controlled

**2.05 BRANCH SELECTOR UNITS****A. GENERAL:****1. SINGLE-PORT BRANCH SELECTOR BOX**

- a. The BSQ36TVJ, BSQ60TVJ, and BSQ96TVJ, are designed specifically for use with VRV IV, VRV IV X, VRV EMERION VRV AURORA, and T-series Water Cooled heat recovery system components.
- b. The single port branch selector boxes BSQ\_T shall provide individual control and changeover for one group of indoor units.
- c. These BSQ\_T branch controllers shall support low ambient cooling down to -4F° to connected indoor units.
- d. These selector boxes shall be factory assembled, wired, and piped.
- e. These branch selector boxes shall have a heat-by-pass control loop inside the units to prevent overheating of space during heating cycles
- f. These selector boxes must be mounted indoors.
- g. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

**2. STANDARD MULTI-PORT T-SERIES BRANCH SELECTOR BOX**

- a. The BS4Q54TVJ, BS6Q54TVJ, BS8Q54TVJ, BS10Q54TVJ and BS12Q54TVJ, are designed specifically for use with VRV IV, VRV IV X, VRV EMERION VRV AURORA, and T-series Water Cooled heat recovery system components.
- b. These branch selector boxes shall provide individual control and changeover for multiple groups of indoor units.
- c. These selector boxes shall be factory assembled, wired, and piped.
- d. These selector boxes must be mounted indoors.
- e. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

**3. MULTI-PORT FLEX BRANCH SELECTOR BOX SERIES**

- a. The BSF4Q54TVJ, BSF6Q54TVJ, and BSF8Q54TVJ are designed specifically for use with VRV IV, VRV IV X, VRV EMERION VRV AURORA, and T-series Water Cooled heat recovery system components.
- b. These branch selector boxes shall provide individual control and changeover for multiple groups of indoor units.
- c. These branch selector boxes shall allow for Field selectable LEFT/RIGHT/PASS THROUGH piping configuration.
- d. These branch selector boxes shall allow multiple branch selector boxes to be connected downstream of the first Branch selector box in series in series.
- e. These Branch selector boxes when connected in series shall be able to support a total indoor load of up to 230MBH.
- f. The EEV heads and motors used in the branch selector box shall be accessible via a quick access panel without disassembly of the electrical box.

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- g. The electrical box of the 4-port branch selector box shall be field re-locatable to left, right, and back side of the main cabinet.
- h. These branch selector boxes shall allow connected indoor units to operate in cooling mode down to -4F without any additional field installed accessories
- i. Labels shall be displayed close to the incoming 3 pipes to facilitate clear identification and eliminate cross piping.
- j. The branch selector boxes shall employ EEV with the ability to control up to 6000 pulses
- k. These selector boxes shall be factory assembled, wired, and piped.
- l. These selector boxes must be mounted indoors.
- m. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

4. The number of connectable indoor units shall be in accordance with the table below:

<b>BRANCH SELECTOR TYPE</b>	<b>MODEL NUMBER</b>	<b>MAXIMUM CONNECTABLE COOLING CAPACITY</b>	<b>MAXIMUM NUMBER OF CONNECTABLE INDOOR UNITS PER BRANCH</b>
SINGLE-PORT	BSQ36TVJ	36,000 Btu/h	4
	BSQ60TVJ	60,000 Btu/h	8
	BSQ96TVJ	96,000 Btu/h	8
MULTI-PORT T-SERIES	BS4Q54TVJ	144,000 Btu/h	5
	BS6Q54TVJ	216,000 Btu/h	5
	BS8Q54TVJ	290,000 Btu/h	5
	BS10Q54TVJ	290,000 Btu/h	5
	BS12Q54TVJ	290,000 Btu/h	5
MULTI-PORT FLEX-SERIES	BSF4Q54TVJ	144,000 Btu/h*	5
	BSF6Q54TVJ	216,000 Btu/h*	5
	BSF8Q54TVJ	290,000 Btu/h*	5

\* For multiple branch selector box connected in series, refer to the engineering manual for details.

**B. UNIT CABINET**

- 1. These units shall have a galvanized steel plate casing.
- 2. Each cabinet shall house 3 electronic expansion valves for refrigerant control per branch.
- 3. The cabinet shall contain one subcooling heat exchanger per branch.
- 4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
- 5. Nominal sound pressure levels shall be measured and published on the submittals by the manufacturer. The sound levels must not exceed the values below.
  - a. If an alternative manufacturer is selected, the mechanical contractor shall provide, at their own cost and expense, any additional material and labor to meet the below published sound levels

<b>BRANCH SELECTOR TYPE</b>	<b>MODEL NUMBER</b>	<b>SOUND LEVEL dB(A) OPERATION</b>	<b>SOUND LEVEL dB(A) MAX</b>
SINGLE PORT	BSQ36TVJ	35	40

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	BSQ60TVJ	41	45
	BSQ96TVJ	41	45
MULTI-PORT STANDARD T- SERIES	BS4Q54TVJ	38	45
	BS6Q54TVJ	39	47
	BS8Q54TVJ	39	47
	BS10Q54TVJ	40	48
	BS12Q54TVJ	40	48
	BSF4Q54TVJ	37	47
MULTI-PORT FLEX-SERIES	BSF6Q54TVJ	40.5	50
	BSF8Q54TVJ	40.5	50

## DIMENSIONS:

b. The branch selector units shall not exceed dimensions stated in the table below.

BRANCH SELECTOR TYPE	MODEL NUMBER	HEIGHT Inches (mm)	WIDTH Inches (mm)	DEPTH Inches (mm)
SINGLE PORT	BSQ36TVJ	8-1/8 (207)	15-1/4 (388)	12-13/16 (326)
	BSQ60TVJ	8-1/8 (207)	15-1/4 (388)	12-13/16 (326)
	BSQ96TVJ	8-1/8 (207)	15-1/4 (388)	12-13/16 (326)
MULTI-PORT STANDARD T- SERIES	BS4Q54TVJ	11-3/4 (298)	14-9/16 (370)	18-15/16 (480)
	BS6Q54TVJ	11-3/4 (298)	22-13/16 (580)	18-15/16 (480)
	BS8Q54TVJ	11-3/4 (298)	22-13/16 (580)	18-15/16 (480)
	BS10Q54TVJ	11-3/4 (298)	32-5/16 (820)	18-15/16 (480)
	BS12Q54TVJ	11-3/4 (298)	32-5/16 (820)	18-15/16 (480)
MULTI-PORT FLEX-SERIES	BSF4Q54TVJ	9 -1/2 (241)	13-3/4 (348)	23-3/4 (603)
	BSF6Q54TVJ	9 -1/2 (241)	23-3/8 (593)	23-3/4 (603)
	BSF8Q54TVJ	9 -1/2 (241)	23-3/8 (593)	23-3/4 (603)

## 6. REFRIGERANT VALVES:

- The unit shall be furnished with 3 electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
- The refrigerant connections must be of the braze type.
- In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundancy must be provided.
- Multiple indoor units may be connected to a branch selector box with the use of a REFNET™ joint provided they are within the capacity range of the branch selector.
- These branch selector boxes shall support up to the maximum capacity per port shown in the table below

BRANCH SELECTOR TYPE	MODEL NUMBER	MAXIMUM CAPACITY PER PORT
SINGLE PORT	BSQ36TVJ	36,000 Btu/h
	BSQ60TVJ	60,000 Btu/h
	BSQ96TVJ	96,000 Btu/h
MULTI-PORT T-SERIES	BS4Q54TVJ	54,000 Btu/h

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	BS6Q54TVJ	54,000 Btu/h
	BS8Q54TVJ	54,000 Btu/h
	BS10Q54TVJ	54,000 Btu/h
	BS12Q54TVJ	54,000 Btu/h
MULTI-PORT FLEX-SERIES	BSF4Q54TVJ	54,000 Btu/h
	BSF6Q54TVJ	54,000 Btu/h
	BSF8Q54TVJ	54,000 Btu/h

**CONDENSTATE REMOVAL:**

- f. The unit shall be hermetically sealed to prevent condensation build up inside the unit, and not require use of a secondary condensate collection pan. A safety device or secondary drain pan shall be installed by the mechanical contractor to comply with the applicable mechanical code, if an alternate manufacturer is selected.

**7. ELECTRICAL:**

- a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
- b. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
- c. The minimum circuit amps (MCA) shall be 0.1 and the maximum overcurrent protection amps (MOP) shall be 15.
- d. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

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**2.06 INDOOR/EVAPOTATOR UNITS**

**PART 3 EXECUTION**

**END OF SECTION**

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**APPENDIX A**

**HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)**

- 1) The alternate equipment supplier shall provide to the bidding mechanical contractor a complete equipment data package.
  - a) This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable.
  - b) The mechanical contractor shall request and receive the equipment data package 15 days prior to bid date and submit this package with the alternate bid.
  - c) The mechanical contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment. The contractor bids an alternate manufacturer with full knowledge that that manufactures product may not be acceptable or approved.
  - d) All equipment must have visible and permanent label clearly identifying the original manufacturer of the equipment. These labels shall have original manufacturer's name and contact information and be located both inside and outside the equipment and on all equipment-related literature. Submittals shall include the above statement as confirmation by supplier that all conditions are agreed to and complied to. Failure to comply with these requirements shall be sufficient cause for rejection of the submittal and product with no further consideration.
- 2) The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation.
  - a) The drawing format shall be .dxf or equivalent, on 30"x42" sheets.
  - b) The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings.
  - c) The alternate equipment supplier shall prepare the following drawings:
    - i) XXX HVAC Floor Plan
    - ii) XXX HVAC Refrigerant Piping Plan
    - iii) XXX HVAC Refrigerant Piping/Controls Details
    - iv) XXX HVAC Details
    - v) XXX HVAC Schedules
  - d) The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.
  - e) Provide (2) drawing package sets plotted on 20 lb. vellum. Provide (1) drawing package in electronic format (.dxf files) on CD.
  - f) The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.
- 3) The equipment supplier shall submit, as part of the equipment data package, condensing unit data sheets. Data sheets to include the following:
  - a) COOLING capacities at project design conditions:
    - i) Cooling (Btu/h)
    - ii) Cooling Input Power:
      - (1) Ducted (kW)

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- (2) Ductless (kW)
  - (3) Mixed (kW)
- iii) Part Load IEER:
  - (1) Ducted
  - (2) Ductless
  - (3) Mixed
- iv) SCHE
- v) Full Load EER:
  - (1) Ducted
  - (2) Ductless
  - (3) Mixed
- b) HEATING capacities at project design conditions:
  - i) Heating (Btu/h)
  - ii) Heating Input Power:
    - (1) Ducted (kW)
    - (2) Ductless (kW)
    - (3) Mixed (kW)
  - iii) Full Load COP @ 47°F:
    - (1) Ducted
    - (2) Ductless
    - (3) Mixed
  - iv) Full Load COP @ 17°F:
    - (1) Ducted
    - (2) Ductless
    - (3) Mixed
- c) The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.
  - i) OPERATING TEMPERATURE RANGE:
    - (1) Cooling
    - (2) Heating
  - ii) POWER SUPPLY:
    - (1) Maximum Circuit Amps (MCA)
    - (2) Maximum Overcurrent Protection Amps (MOP)
    - (3) Maximum Starting Current (MSC)
    - (4) Condenser Fan Motor
  - iii) REFRIGERANT:
    - (1) Refrigerant type and charge details including field charge for piping to ensure code compliance.
    - (2) Control of refrigerant temperature based on weather and load or alternative function.
  - iv) UNIT DATA:
    - (1) Max. number of indoor units
    - (2) Sound pressure level at 3ft (dBA)
    - (3) Weight (lbs)
    - (4) Dimensions

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- (5) Demand limit function description
  - (6) Details on sequential start functionality
  - (7) Coil anticorrosion data
- 4) The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.
  - a) Room Temperature (Cooling)
  - b) Room Temperature (Heating)
  - c) Ambient Temperature (Summer)
  - d) Ambient Temperature (Winter)
  - e) Defrost De-rate Factor
  - f) Refrigerant Piping Loss
- 5) The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:
  - a) Capacities at project design conditions:
    - i) Cooling (Btu/h)
    - ii) Cooling Input Power (kW)
    - iii) Part Load IEER
    - iv) SCHE
    - v) Full Load EER
    - vi) Heating (Btu/h)
    - vii) Heating Input Power (kW)
    - viii) Full Load COP@47°F
    - ix) Full Load COP@17°F
    - x) Air Flow (CFM)
  - b) External Static Pressure (ESP)
  - c) Electrical Data (MAC, MOP, MSC, RLA)
  - d) Weight (lbs)
  - e) Dimensions
- 6) The equipment supplier shall provide a certificate which states that the equipment has a minimum salt spray resistance of 1000 hours.
- 7) The equipment supplier shall submit the warranty certificate to the mechanical contractor.

**Variable Refrigerant Volume HVAC System - 238129**



**SECTION 26-0500 - COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in sections of Division 01.
- B. Related Requirements:
  - 1. Division 01 – General Requirements.
  - 2. Section 03 30 00 – Cast-in-Place Concrete.
  - 3. Section 09 90 00 – Painting and Coating.
  - 4. Division 14 – Conveying Equipment.
  - 5. Division 23 – HVAC.
  - 6. Division 26 – Electrical.
  - 7. Division 27 – Communications.
  - 8. Division 28 – Electronic Safety and Security.
  - 9. Division 31 – Earthwork.
  - 10. Division 33 – Site Improvements.
- C. Related Industry Standards: The most current version of the following industry standards.
  - 1. ASTM D 709 – Laminated Thermosetting materials.
  - 2. ANSI/NEMA FB-1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
  - 3. ANSI/NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 4. California Electrical Code (CEC).
  - 5. IEEE C57.12.28 – Standard for Pad-Mounted equipment Enclosure Integrity.
  - 6. IEEE 1584 – Performing Arc-Flash Hazard Calculations.
  - 7. UL/ANSI 1 – Standard for Flexible Metal Conduit.
  - 8. UL/ANSI 1242 – Standard for Electrical Intermediate Metal Conduit.

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9. UL/ANSI 506 – Standard for Specialty Transformers.
10. UL/ANSI 6 – Electrical Rigid Metal Conduit-Steel.
11. UL/ANSI 6A – Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel.
12. UL 797 – Electrical Metallic Tubing-Steel.
13. UL/ANSI 870 – Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
14. UL/ANSI 891 – Standard for Safety Switchboards.

### 1.02 BASIC ELECTRICAL REQUIREMENTS

#### A. Quality Assurance:

1. Work shall be performed by CONTRACTOR'S personnel possessing the skills and experience obtained in performing work of similar scope and complexity.
2. Refer to related division(s) specifications for other requirements.

#### B. Drawings and Specifications Coordination:

1. For purposes of clearness and legibility, Drawings are essentially diagrammatic, and the size and location of equipment is indicated to scale whenever possible. Verify conditions, dimensions, indicated equipment sizes, and manufacturer's data and information as necessary to install the Work of this Division. Coordinate location and layout with other Work.
2. Verify final locations for rough-in with field measurements and with the requirements of the equipment to be connected.
3. Drawings indicate required size and points of termination of conduits, number and size of conductors, and diagrammatic routing of conduits. Install conduits with minimum number of bends to conform to structure, avoid obstructions, preserve headroom, keep openings and passageways clear, and comply with applicable code requirements.
4. Routing of conduits may be changed provided that the length of any conduit run is not increased more than 10 percent of length indicated on the Drawings.
5. Outlet locations shall be coordinated with architectural elements prior to start of construction. Locations indicated on the Drawings may be distorted for clarity; CONTRACTOR shall coordinate in the field prior to rough-in work.
6. Coordinate electrical equipment and materials installation with building components and the Work of other trades.
7. Equipment disconnects shall be readily accessible and free of obstructions.

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8. When extending or intercepting existing electrical facilities, CONTRACTOR shall Coordinate and verify existing conditions.
- C. Terminology:
1. Signal Systems: Applies to clock, bell, fire alarm, annunciator, sound, public address, buzzer, telephone, television, inter-communication, elevator access controls, lighting control systems and security systems.
  2. Low Voltage: Applies to signal systems operating at 120 volts and less, and power systems operating at less than 600 volts. Medium voltage: Applies to power systems operating at more than 600 volts.
  3. UL: Underwriter's Laboratories Inc, Nationally Recognized Testing Laboratory (NRTL), or equal.
- D. Regulations: Work shall comply with the requirements of authorities having jurisdiction and the California Electrical and Building Codes. Material shall conform to regulations of the National Board of Fire Underwriters for electrical wiring and apparatus. Materials shall be new and listed by UL, or another NRTL.
- E. Structural Considerations for Conduit Routing:
1. CONTRACTOR shall provide DSA approved calculations and drawings as necessary for any construction and/or alterations requiring conduits to pass through or interfere with any structural members, or where notching, boring or cutting of the structure is necessary, or where special openings through walls, floors, footings, or other buildings elements, or where notches and bored holes in wood or steel are required. All work shall conform to CBC, Part 2, Title 24 requirements.
  2. Concrete encasement for underground conduits that abuts a foundation wall or underground structure shall rest on a haunch integral with wall or structure, or shall extend down to footing projection, or shall be doweled into structure unless otherwise indicated. Underground structures shall include maintenance holes; pull boxes, vaults, and buildings.
- F. Electrically Operated Equipment and Appliances:
1. Furnished Equipment and Appliances:
    - a. Work shall include furnishing and installing wiring enclosures and complete connections of electrically operated equipment, appliances and electrical control devices, which are specified to be furnished and installed in this or other sections of the Specifications. Wiring enclosures shall be concealed except where exposed work is indicated on the drawings.
    - b. Provide all connections necessary for installation of equipment. Equipment shall be tested for proper operation, including proper rotation of motorized equipment. If outlets are of incorrect electrical characteristics, or any specified equipment fails to operate properly,

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CONTRACTOR shall repair and/or replace the outlet and/or equipment.

2. Equipment and Appliances Furnished by Others:

- a. Equipment and appliances indicated on Drawings as "Not In Contract" (NIC), "furnished by others," or "furnished by the OWNER," will be delivered to the Project site. Required electrical connections shall be performed for such equipment and appliances. Motorized equipment will be furnished factory-wired to a control panel or junction box unless otherwise indicated. Appliances will be furnished equipped with portable cord and cap. Provide disconnect switches where required.
- b. Connections to equipment furnished under this Division shall be part of the Work of this section. Work shall include internal wiring, installation, connection and adjustment of bolted drive motors in which the motor is supplied as a separate unit, and connections only for equipment furnished with factory installed internal wiring, except as further limited by Drawings and this Specification. Work shall include furnishing and installing suitable outlets, disconnecting devices, starters, push-button stations, selector switches, conduit, junction boxes, and wiring necessary for a complete electrical installation. Work shall also include furnishing and installing conduit and boxes for HVAC control systems, furnished under Division 23. Devices and equipment furnished shall be of same type used elsewhere on the Work or as specified.
- c. Electrical equipment furnished under other sections, for installation and connection under Work of this section, will be delivered to the Project site ready for installation.
- d. Mechanical equipment furnished under other sections, and requiring electrical connection under this section, will be set in place as part of the Work of the section furnishing such equipment unless noted otherwise.
- e. Suitability and condition of equipment furnished under other sections shall be determined in advance of installation. Immediate notice of damage, unsuitability, or lack of parts shall be given to the entity providing such equipment.

G. Power Distribution System Reports: For fault current, coordination and Arc-Flash system report requirements refer to applicable electrical distribution equipment sections. for specific requirements.

H. Protection of Materials:

1. Protect materials and equipment from damage and provide adequate and proper storage facilities during progress of the Work. Damaged materials and/or equipment shall be replaced.

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### **I. Cleaning:**

1. Exposed parts of Work shall be left in a neat, clean, usable condition. Finished painted surfaces shall be unblemished and metal surfaces shall be polished.
2. Thoroughly clean parts of apparatus and equipment. Exposed parts to be painted shall be thoroughly cleaned of cement, plaster, and other materials. Remove grease and oil spots with solvent. Such surfaces shall be wiped, and corners and cracks scraped out. Exposed rough metal shall be smooth, free of sharp edges, carefully steel brushed to remove rust and other spots, and left in proper condition to receive finish painting.
3. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

### **J. WARRANTIES**

1. Provide one-year warranty on all material and labor performed, unless noted otherwise in specific sections.

## **PART 2 - PRODUCTS - NOT USED**

## **PART 3 - EXECUTION**

### **3.01 GENERAL REQUIREMENTS**

- A. Advise the Inspector before starting the Work of this Division.
- B. Exposed conduits shall be painted to match the surfaces adjacent to installation.
- C. Salvaged materials removed from buildings shall be removed from the Project site as required by the OAR.
- D. Trenches outside of barricade limits shall be backfilled and paved within 24 hours after being inspected by the Inspector. Provide traffic plates during the time that trenches are open in traffic areas and in areas accessible to students and staff.
- E. Where existing structural walls are cored for new conduit runs, separation between cored holes shall be three inches edge to edge from new or existing holes, unless otherwise required by the Architect. All coring to be laid out and reviewed by Architect prior to drilling. CONTRACTOR to verify location of structural steel, rebar, stress cabling or similar prior to lay out.
- F. Electrical equipment shall be braced and anchored for CBC Seismic Design requirements, or as otherwise indicated on the Drawings.

### **3.02 DELIVERY STORAGE AND HANDLING**

- A. Deliver products to project site with proper identification, which shall include names, model numbers, types, grades, compliance labels, and similar information needed for

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District identification; all products and materials shall be adequately packaged and protected to prevent damage during shipment, storage, and handling.

- B. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion.

### **3.03 CUTTING AND PATCHING**

- A. Cutting and patching of electrical equipment, components, and materials shall include the removal and legal disposal of selected materials, components, and equipment.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- C. Repair or restore other work or surfaces damaged as a result of the work performed under this contract.

### **3.04 CLEANUP**

- A. Remove rubbish, debris and waste materials and legally dispose off the Project site.
- B. Remove equipment and implements of service, and leave entire work area neat and clean, to the satisfaction of the Owner Authorized Representative (OAR).

### **3.05 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**END OF SECTION**

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**SECTION 26-0513 - BASIC ELECTRICAL MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Boxes, enclosures, keys and locks.
  - 2. Receptacles and switches.
  - 3. Identifications and signs.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Division 26 – Electrical.
  - 3. Division 27 – Communications.
  - 4. Division 28 - Electronic Safety and Security.

**PART 2 - PRODUCTS**

**2.01 BOXES, ENCLOSURES, KEYS AND LOCKS**

- A. Outlet Boxes and Fittings:
  - 1. Outlet boxes installed in concealed Work shall be galvanized steel, pressed, or welded type, with knockouts.
  - 2. In exposed Work, where conduit runs change direction or size, outlet boxes and conduit fittings shall be cast metal with threaded hubs cast integral with box or fitting.
  - 3. Fittings shall be cast metal and non-corrosive. Ferrous metal fittings shall be cadmium-plated, or zinc galvanized. Castings shall be true to pattern, smooth, straight, with even edges and corners, of uniform thickness of metal, and shall be free of cracks, gas holes, flaws, excessive shrinkage, and burnt-out sand.
  - 4. Covers for fittings shall be galvanized steel or non-corrosive aluminum and shall be designed for particular fitting installed.
  - 5. Light fixture outlets shall be 4-inch octagon, 4-inch square, 2 1/8-inch deep or larger, depending upon number of conductors or conduits therein. Plaster

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rings shall be furnished with round opening with two ears drilled 2 23/32 inches center to center.

6. For local device outlets provide 4-inch square 2 1/8-inch deep, boxes for single gang, 5-inch square boxes for two-gang, and special solid gang boxes with gang plaster ring for more than two switches.
7. For TV outlets, and horns and strobes provide manufacturer's supplied back box as needed. For television outlets, provide 4-gang deep boxes and 4-gang plaster rings.
8. Plaster rings shall be provided on flush-mounted outlet boxes except where otherwise indicated or specified. Plaster rings shall be same depth as finished surface. Install approved ring extension to obtain depth to finish surface.
9. In existing plywood wall or drywall construction, and where flexible steel conduit is fished into walls, single-gang and 2-gang outlets for wiring devices may be sectional steel boxes with plaster ears. Boxes shall be fastened to plywood with flat-head screws in each plaster ear screw hole. Boxes fastened to gypsum board shall be Racor, Appleton, Cooper, Bowers, or equal.
10. Factory made knockout seals shall be installed to seal box knockouts, which are not intact.
11. Where flexible conduit is extended from flush outlet boxes, provide and install weatherproof universal box extension adapters.

### B. Junction and Pull boxes:

1. Junction and pull boxes, in addition to those indicated, shall only be used in compliance with codes, recognized standards, and Contract Documents.
2. Interior and non-weatherproof boxes shall be constructed of blue or galvanized steel with ample laps, spot welded, and shall be rigid under torsion and deflecting forces. Boxes shall be furnished with auxiliary angle iron framing where necessary to ensure rigidity.
3. Covers shall be fastened to box with enough machine screws to ensure continuous contact all around. Flush type boxes shall be drilled and tapped for cover screws if boxes are not installed plumb. Surfaces of pull and junction boxes and covers shall be labeled in black marker ink designating system, panelboard and circuit designation contained in box. In exposed Work, designation shall be installed on inside of pullbox or junction box cover.
4. Weatherproof NEMA 3R pull and junction boxes shall conform to foregoing for interior boxes with following modifications:
  - a. Cover of flush mounting boxes shall be furnished with a weather-tight gasket cemented to, and trimmed even with, cover all around.

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- b. Surface or semi-flush mounting pull and junction boxes shall be UL, or another Nationally Recognized Testing Laboratory (NRTL) listed as rain-tight and shall be furnished complete with threaded conduit hubs.
  - c. Exposed portions of boxes shall be galvanized and finished with one prime coat and one coat of baked-on gray enamel, unless already furnished with factory baked-on finish.
- 5. Junction and pull boxes shall be rigidly fastened to structure and shall not depend on conduits for support.
- 6. Underground Concrete Pull Boxes:
  - a. Pre-cast concrete pull boxes. Concrete pull boxes shall be traffic type, reinforced for H-20 wheel loading, pre-cast concrete. Pull boxes with inside dimensions of 2 feet by 3 feet by 3 feet deep shall consist of a base section, top ring, and cover. Base section shall be furnished with 2 knockouts measuring 10 inches by 10 inches in each 3 feet side, and one 20 inches by 20 inches knockout in each 2-foot side. Pull boxes with inside dimension 4 feet by 4 feet by 4 feet deep shall consist of a base section, midsection, topping, and cover. Base section shall be furnished with 2 knockouts measuring 8-inch by 16-inch on each of two opposite sides, and one 20-inch by 20-inch knockout on each of other two opposite sides. Pull boxes shall be furnished with a minimum of 6-inch diameter sump knockout and one-inch diameter ground rod knockout. In pull boxes, furnish and install cable racks on walls. Racks shall be furnished with 3 porcelain cable holders on vertical steel mounting bars. Pull boxes shall be furnished with 3/4-inch diameter pull irons. Covers shall be traffic-type consisting of steel safety plate bolted to frame. Covers shall be marked as electrical, power, or signal as required.
  - b. Provide end bells in duct entrances. Terminate each metal conduit with insulated bushing provided with a grounding terminal.
  - c. Install pulling irons on opposite walls and below horizontal centerlines of ducts and bricked-up openings, and in bottom. Install pulling irons with each end hooked around a reinforcing bar.
  - d. Remove floor drain knockout and provide a depth of 24 inches of crushed rock below box extending a minimum of 12 inches beyond on all sides.
  - e. Permanently and effectively ground metal equipment cases, cable racks, and similar items in pull boxes to site grounding electrode system. Provide grounding conductor in compliance with CEC Article 250.
  - f. Provide 6-inch deep sand base under pull boxes.

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- g. Identify power and signal cables by tagging in manholes and pull boxes. Tie securely to cables with nylon cord.
    - h. Top of steel plate shall provide a minimum coefficient of static friction of 0.5 for either wet or dry locations, when tested for any shoe sole material. Test shall comply with ASTM D 1047 or F 489 or F 609 standards. Submit manufacturer's test results for Architect's review as part of materials and equipment submittals.
    - i. The use of underground extension boxes shall be limited to not more than 1 times the original depth of pull box.
    - j. Approved Products: Oldcastle Precast, Jensen Precast, Kistner, Western Precast, or OWNER approved equal.
  - 7. Underground utility boxes shall be reinforced concrete with non-setting shoulders to prevent settlement following installation. Boxes shall be furnished with cast iron cover with finger hole, size as indicated on Drawings. Utility boxes shall be as manufactured by Oldcastle, Jensen, Kistner, Western Precast, or equal.
  - 8. Manholes, vaults, and pull boxes required by a utility company, and installed as part of this Contract, shall meet requirements of servicing utility company.
- C. Floor Outlets:
- 1. Floor Outlets (except for extension outlets) shall be cast iron, watertight floor boxes with flush brass floor plates, and shall be set to finish flush with finish floor covering, whether it be carpeted, wood, resilient floor covering, or other finish materials.
    - a. Floor boxes shall be used in offices, classrooms, areas only.
    - b. Approved Products: Harvey Hubbell Inc. B-2503, Thomas & Betts 640 series, Legrand Omnibox, or OWNER approved equal.
  - 2. Telephones above floor outlets, where not subject to water, shall be provided with Harvey Hubbell Inc. SC-3098 pedestals with SC309T plates. Refer to other Division 26 sections. Floor boxes shall be used in offices, classrooms and in Library areas only.
    - a. Approved Products: Legrand 525 series, Thomas & Betts FPT-400 Series, or OWNER approved equal
  - 3. Plugs above floor outlets where not subject to water shall be provided with pedestal s and device plates. Refer to other Division 26 sections. Floor boxes shall be used in offices, classrooms, and library areas only.

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- a. Approved products: Pedestals shall be Legrand 525 series, Thomas & Betts FPT-400 Series, Harvey Hubbell Inc. SC-3098; Device plates shall be Hubbell SS309D, or District approved equal.
- 4. Two gang and single box pedestal boxes shall be listed for wet locations where subject to water. Provide required cover plates.
  - a. Floor outlets shall be used in any areas where floors are subjected to water.
  - b. Approved products: Single gang boxes - Hubbell SA-6687. Two gang boxes shall be Hubbell SA-6885, or OWNER approved equal.
- 5. Extension floor outlets shall be cast iron with cast iron covers, and 1/2-inch offset entries for above-floor conduit extensions; Boxes shall be designed to permit access to wiring without disturbing above-floor extensions and shall be set flush with finish floor.
- 6. Above floor service fittings for data outlets and surge suppression receptacles shall be faceplate interchangeable, die cast aluminum.
  - a. Approved products: Hubbell SC3098 with cover plates SS309DS, Legrand 525 series, Thomas & Betts FPT-400 Series, or OWNER approved equal.
- D. Floor Pockets – Plugging Boxes:
  - 1. Three-Gang floor lighting pockets shall be flush floor type recess floor mounted enclosure, with cast iron floor plate and hinged cast iron door notched for cables.
    - a. Each floor pocket shall be provided with three 20-amp, 3 wire, 125-volt receptacles with matching caps.
    - b. Approved products: Legrand or Hubbell Recessed Floor Boxes, C.W. Cole TLS 353-6, or equal, for wood floors and C.W. Cole TLS-353-6-C, or OWNER approved equal for concrete slabs.
  - 2. Single Gang:
    - a. Receptacle floor pockets shall be single gang, flush floor type, with cast iron floor plate, hinged cast iron door notched for cable and cast-iron box. Provide each pocket with a standard, single grounding type receptacle unless otherwise indicated.
      - 1) Approved Products: C.W. Cole TLA-362-1-FE, or OWNER approved Legrand or Hubbell recessed floor box, or OWNER approved equal. For wood floors provide C.W. Cole TLS-362-1, or OWNER approved equal.

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b. Microphone or projector floor pockets shall be single gang flush floor type with cast iron floor plate, hinged cast iron door, notched for cable and cast-iron box.

1) Approved Products: Legrand or Hubbell recessed floor box, C.W. Cole TLA-362-3-FE, C.W. Cole TLS-362-3, in wood floors, or OWNER approved equal.

E. Keys and Locks:

1. Provide two keys with furnished door locks, including cabinet door locks and switchboard locks, two keys for lock switches on switchboards or control panels, and two keys with interlocks or other furnished lock switches. Deliver keys to OAR.

2. Special keys and locks shall only be provided where specified. Locks shall be keyed to Corbin No. 60 or 70 as follows:

a. Access to operate equipment shall be keyed to Corbin 60.

b. Access to service areas shall be keyed to Corbin 70.

## 2.02 RECEPTACLES AND SWITCHES

A. Receptacles:

1. Duplex receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be wired on the side and back with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction. Receptacle back body shall be PVC. Receptacle face shall be ivory, impact resistant nylon. Receptacles shall have triple wipe brass power contacts.

a. Approved products:

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>
	<u>Leviton</u>	
(20 amps) NEMA 5-20	PS5362-I	HBL5362-I
	5362-I	
(15 amps) NEMA 5-15	PS5262-I	HBL5262-I
	5262-I	

Equal products approved by OWNER may be acceptable.

2. Duplex receptacles on circuits supplied by panel boards with integral surge suppression shall be Pass & Seymour model number PS5262BL (blue), Hubbell DRUBTVSS15, Leviton 5262-SBU, 15-amps, 120-volts, or OWNER approved equal.

3. Single receptacles shall be heavy-duty specification grade, grounding type. Terminal screws shall be back and side wire with internal screw pressure plates. Mounting strap shall feature heavy-duty brass construction.

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Receptacle back body shall be thermoplastic. Receptacle face shall be ivory, impact resistant nylon. Receptacles shall have triple wipe brass power contacts. For circuits consisting of one single receptacle only, ampere rating of receptacle shall be same as circuit breaker or fuse.

a. Approved products:

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>
	<u>Leviton</u>	
(20 amps) NEMA 5-20R	5361-I	HBL5361-I
	5361-I	
(15 amps) NEMA 5-15R	5261-I	HBL5261-I
	5261-I	

Equal products approved by OWNER may be acceptable.

4. Single 15 and 20-amps receptacles on circuits supplied by panel boards with integral surge suppression shall be blue in color.

a. Approved products: Pass & Seymour NEMA 5-20R model number 5361-BL (blue), NEMA 5-15R model number 5261-BL (blue), or OWNER approved equal.

5. Kiln and range receptacles, provide 3-pole, 4-wire, grounding type, rated 50 amps or as indicated on plans. Receptacle shall be rated 125/250 volts NEMA 14-50R. Provide 2-gang, stainless steel plates.

a. Approved products:

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 14-50R	3894	HBL9450A	279
WALL PLATE	SS703	S703	84026

Equal products approved by OWNER may be acceptable.

6. Dryer receptacles. Provide 3-wire, non-grounding type, rated 30 amps at 125/250 volts, NEMA 10-30R, with 2-gang stainless steel plates. Coordinate location of junction box with the work of Section 10 2815, Hand and Hair Dryers.

a. Approved Products:

<u>NEMA #</u>	<u>Pass&amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
<u>NEMA 10-30R</u>	3860	HBL9350	5207
<u>WALL PLATE</u>	SS703	S703	84026

Equal products approved by OWNER may be acceptable.

7. Provide specification grade ground-fault circuit interrupter (GFCI) type receptacles in accordance with 2010 UL standards. GFCI receptacles shall have a trip indication light. Receptacle terminal screws shall be back and side wire with internal screw pressure plates. Test and reset buttons shall match device body and shall be ivory. GFCI receptacles shall be manufactured in standard configuration for installation with stainless steel smooth plates.

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Exterior mounted receptacles shall be mounted inside weatherproof enclosure.

a. Approved products:

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 5-20R	2095-I	GFR5352-IA	7899-I
NEMA 5-15R	1595-I	GFR5252-IA	8598-I

Equal products approved by OWNER may be acceptable.

8. Provide weatherproof receptacles, except where otherwise indicated or specified, consisting of GFCI receptacles, as specified herein, and metal plates with die-cast lockable hinged lids and weatherproof mats;

Tamper-resistant receptacles with thermoplastic dual mechanism shutter system to help prevent insertion of foreign objects. Receptacles shall have extra heavy-duty brass, one-piece mounting strap with integral ground. Receptacles shall be ivory color, impact resistant nylon face and back body.

a. Approved products:

<u>NEMA #</u>	<u>Pass &amp; Seymour</u>	<u>Arrow Hart</u>	<u>Leviton</u>
NEMA 5-20R	TR63-I	TR8300V	8300SGI
NEMA 5-15R	TR62-I	TR8200V	8200SGI

Equal products approved by OWNER may be acceptable.

9. Provide transient voltage surge suppression (TVSS) receptacles offering metal oxide varistors (MOVs) protecting normal and common modes, (L-N, L-G, N-G) with 500V suppressed voltage. TVSS devices shall offer 3-mode equal protection with 210 joules minimum per mode of energy absorption and 13,000-amp maximum surge capability. TVSS devices shall have 3 thermal fuses and two over-current protection fuses. TVSS devices shall have LED visual only surge status indicator to alert user to surge suppression circuit condition. Visual indicator will be illuminated (red) when power is on and surge suppression circuit is fully functional. Visual indicator will not be illuminated when power is off or unit experiences loss of surge suppression protection. Terminals shall be back and side wire including ground terminal. Color shall be blue.

a. Approved Products

<u>NEMA #</u>	<u>Pass&amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
NEMA 5-20R	5352BLSP	HBL5360SA	5380B
NEMA 5-15R	5252BLSP	HBL5260SA	5280B

Equal products approved by OWNER may be acceptable.

**B. Switches**

1. Local Switches:

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- a. Local switches shall be high strength thermoplastic toggle, industrial grade, rated 20 amps at 120-277 volts AC only, with plaster ears, external screw pressure plate back and side wired, and standard size composition cups which fully enclose mechanism. Switches shall be approved for installation at currents up to full rating on resistive, inductive, tungsten filament lamp and fluorescent lamp loads, and for up to 80 percent of rating for motor loads. Switches shall have oversized silver alloy contacts for long life and better heat dissipation. Provide switches as single pole, double pole, 3-way, 4-way, non-lock type. Provide non-lock type switches with ivory handles;

	<u>Pass &amp; Seymour</u>	<u>Hubbell</u> <u>Leviton</u>
Single pole	PS20AC1I 1221-2I	HBL1221I
Double pole	PS20AC2I 1222-2I	HBL1222I
Three-way	PS20AC3I 1223-2I	HBL1223I
Four-way	PS20AC4I 1224-2I	HBL1224I

Equal products approved by OWNER may be acceptable.

- b. Lock type switches shall be specification industrial grade, 20 amp, 120-277 volts with metal or nylon key guides with on/off indication, and operable by same key. Key shall be District standardized vertically oriented, tamper resistant, forked key with two each 5/16-inch long forks, 5/32-inch spacing between forks and 5/16-inch width overall.

- 1) Approved products:

	<u>Pass &amp; Seymour</u>	<u>Arrow Hart</u>
Single pole w/1201LK Key	PS20AC1L w/#500 Key-2L	1221L
Double pole w/1201LK Key	PS20AC2Lw/#500 Key	1222L
Three-way w/1201LK Key	PS20AC3L w/#500 Key	1223L
Four Way w/1201LK Key	PS20AC4L w/#500 Key	1224L

Equal products approved by OWNER may be acceptable.

- c. Rotary lock switches shall incorporate a tumbler type lock to prevent unauthorized operation. Lock shall be tumbler type by Corbin, keyed to a HH41 key. Lock switch to be installed with pin tumblers facing downward. Key shall be removable in all positions. Each device shall be complete with 2 keys. Keys shall be delivered only to the OAR. Switches shall be rated at 20 amps, 120-volt or 277-volt AC. Switch plates shall be of stainless steel, engraved with on and off positions indicated.

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1) Approved products:

	<u>Arrow Hart</u>
Single pole	AH1191N
Double pole	AH1192N
Three-way	AH1193N
Equal products approved by OWNER may be acceptable.	

- d. Pilot light switches shall be rated 20 amps and shall conform to specifications for local switches. Switches shall be furnished with red, Lexan handles that are lighted by LED lamps. Pilot light shall light when load is on. Pilot light 120-volt switches

1) Approved products:

	<u>Pass&amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
Single pole PLR	PS20AC1-RPL	HBL1221-PL	1221-
Double pole PLR	PS20AC2-RPL	HBL1222-PL	1222-
Three-way PLR	PS20AC3-RPL	HBL1223-PL	1223-
Equal products approved by OWNER may be acceptable.			

- 2) 20 amps, 277 volts rated pilot light switches shall be single pole and shall conform to specifications for local switches, and the requirements of paragraph d above.

a) Approved Products:

	<u>Pass &amp; Seymour</u>	<u>Leviton</u>	<u>Hubbell</u>
PL7	PS20AC1-RPL	1221-7PR	HBL1221-

- e. Provide remote control switches for mechanically held contactors arranged for 3-wire control, toggle type, momentary contact, single pole, 3-position with center off position, rated 20 amps at 120-277 volts AC only, with plaster ears, binding screws for side wiring, standard size composition cups which fully enclose mechanism, and ivory handles.

1) Approved products:

<u>Pass &amp; Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
1251-I	HBL1557-I	1285-I
Equal products approved by OWNER may be acceptable.		

- f. Provide remote control switches for magnetically held contactors arranged for 3-wire control, toggle type, maintained contact, single pole, 3-position with center off position, rated 20 amps at 120-277 volts AC only, with plaster ears, binding screws for side wiring,  
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standard size composition cups which fully enclosed mechanism, and ivory handles.

- 1) Approved products:

<u>Pass and Seymour</u>	<u>Hubbell</u>	<u>Leviton</u>
1225-I	HBL 1385	1285-I

Equal products approved by OWNER may be acceptable.

- g. Momentary Contact locking key type switch. 20A 120/277V center off. Key shall be District standardized vertically oriented, tamper resistant, forked key with two each 5/16" long forks, 5/32" spacing between forks and 5/16" width overall.

- 1) Approved products:

Arrow Hart AH1995L w/ AH2000 key  
Equal products approved by OWNER may be acceptable.

- h. Momentary Contact switch low voltage 1 pole 3A 24VAC 3 position center off. Key for locking switch shall be District standardized vertically oriented, tamper resistant, forked key with two each 5/16" long forks, 5/32" spacing between forks and 5/16" width overall.

- 1) Approved products:

Pass and Seymour Toggle 1081I, Locking 1081KGRY w/#500 Key  
Equal products approved by OWNER may be acceptable.

2. Time Switches and Photoelectric Controls.

- a. Provide time switches with a 7-day, solid-state, electronic type capable of fully automatic or manual operation and housed in a sheet steel enclosure unless built into a panel or switchboard. Resistive or inductive contacts rated for 25-amps, each pole 240-VAC; 5-amps tungsten or 277-VAC pilot duty, each pole 240-VAC. Time switches to contain a non-volatile clock and non-volatile memory with a built-in rechargeable super capacitor power carry-over system. Battery carryover is not acceptable. Provide a minimum of 15 on/off set points per week. Timing to be in one-minute increments with a minimum on or off time of one minute. Time switch digital displays to indicate days of week, hours, and minutes. Display to contain a load status light to indicate when equipment is in operation.

- b. Required :

- 1) Liquid crystal display panel.
- 2) Holiday scheduling: Up to 40 dates may be assigned special holiday schedules, up to one year in advance.

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- 3) Automatically adjusts to and from daylight savings time and for leap year.
  - 4) Contact ratings: 10 amp at 240 VAC.
  - 5) Safety override switch for each circuit to either provide shut down of circuit or to override on.
  - 6) Selective review: All or part of schedule shall be displayed at touch of a key.
  - 7) Super Capacitor for power carry-over system.
  - 8) Supply voltage: 120/277-Volt.
  - 9) 365-day advance scheduling.
  - c. Approved products: Tork Model EW 101B series, Intermatic ET90000 series, or OWNER approved equal.
  - d. Photoelectric control: Shall be rated 2,000 watts, 120V with single pole, single throw, normally closed contact, enclosed in a die-cast aluminum gasketed enclosure with 1/2-inch conduit fitting,
    - 1) Approved products: Tork series 2100, or OWNER approved equal.
3. Emergency Lighting Control Unit
- a. The Emergency Lighting Control Unit shall provide all required functionality to allow a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.
  - b. The emergency lighting control unit shall allow control of emergency lighting fixture 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.
  - c. The device shall have normally closed dry contacts capable of switching 10-amp emergency ballast loads at 120-277 VAC, 60 Hz., 2-amp tungsten loads at 120 VAC, 60Hz., LED loads at 120-277V VAC, 60 Hz

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- d. The device shall have universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.
- e. 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)
- f. The device's normal power input terminal 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.
- g. 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.
- h. Approved products: WattStopper ELCU-100 Emergency Lighting Control Unit, LVS #EPC-PM Series, Lighting Control Design #GR 2001 series, or OWNER approved equal.

## **2.03 IDENTIFICATION AND SIGNS**

### **A. Identification Plates:**

- 1. Provide identification plates for the following unless otherwise specified, for switchboards, unit substations, motor control centers, control panels, push-button stations, time switches, contactors, motor starters, motor switches, panelboards, and terminal cabinets.
- 2. Identification plates shall be of plastic stock and shall adequately describe function, voltage and phase of identified equipment. Where identification plates are detailed or described on Drawings, inscription and size of letters shall be as indicated. For lighting and power panels, identification plates shall indicate panel designation, voltage, and phase of panel. For terminal cabinets, identification plates shall indicate system contained in terminal cabinet.
- 3. Identification plates shall be black-and-white nameplate stock of bakelite with characters cut through black exposing white. Plates shall be furnished with beveled edges and shall be securely fastened in place with No. 4 Phillips-head, cadmium-plated steel, self-tapping screws. Characters shall be 3/16 inch high, unless otherwise indicated.

### **B. Markings:**

- 1. Install identification markings to surface-mounted starters, switches, disconnect switches, contactors, and other devices controlling motors and

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appliances. Provide abbreviations required along with an identifying number. Markings to be provided with locking type stencils using paint of a contrasting color. Figures shall be 3/8 inch high unless otherwise indicated. Dymo Industries Inc., self-sticking plastic labels, with embossed characters made with a typewriter may be installed instead of stencils and paint; p-touch self adhesive plastic, or Brother P-Touch self sticking laminated plastic labels may be installed.

2. High Voltage: High voltage switchboards, cabinets, boxes, and conduits exposed in accessible locations, including under buildings and in attics, are required to be marked "WARNING-HIGH VOLTAGE – ABOVE 600 VOLTS". Markings for switchboards shall consist of 18 gage steel, porcelain enamel sign of standard manufacture. Markings for boxes, cabinets, and conduits shall be by means of stenciling or printed self-adhesive markers, Westline Tel-A-Pipe, or equal. Provide letters of black on orange background and not less than 1-7/8 inches high. On conduit runs, install markings at intervals not exceeding 10 feet in any individual area. Markings shall be installed after other painting Work is complete.

C. Warning Signs:

1. Provide a warning sign on outside of each door or gate to rooms or enclosures containing high voltage equipment. Signs required reading, "WARNING - HIGH VOLTAGE - KEEP OUT". Provide 2-inch high lettering.
2. Provide a warning sign on each high-voltage non-load break disconnect and fused cutout (not oil filled). Signs required reading, "DO NOT OPEN UNDER LOAD". Provide 2-inch-high lettering.
3. Provide signs of standard manufacture, 18 gage steel, with porcelain enamel finish. Provide red lettering on a white background.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION AND SUPPORT OF BOXES**

- A. Install outlet boxes flush with finished surface of wall or ceiling. Install plumb and securely fastened to structure, independent of conduit. Except where otherwise indicated, provide factory-fabricated adjustable attachment bar hangers between studs to support outlet boxes. When installation is performed in fire rated walls, maintain the wall's rating integrity by means of approved fire stop methods.
- B. Outlet boxes installed in suspended or furred ceilings with steel runner or furring channels shall be supported, except where otherwise indicated, by a Unistrut P-4000 Tessco A1200HS-10, Cooper B-Line B22s-HG, or OWNER approved equal channel spanning main ceiling runner channels. Each box shall be supported from its channel by a 3/8-inch 16 threaded steel rod with a Unistrut P-4008, Fastenal #48604, Copper B-Line 78101140346 or OWNER approved equal; nut and a Tomic No. 711-B Adapta-

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Stud, or OWNER approved equal. Rod shall be tightened to a jamb fit with channel and its nut. Box shall be locked to rod by means of a 1/2-inch locknut on stud and a 3/8-inch 16 hex nut locking stud to rod.

- C. Heights of outlets and equipment indicated on Drawings shall govern. In absence of such indications, following heights shall be maintained with heights measured to centerline unless otherwise noted:
1. Install wall-mounted switches at 48 inches above finished floor.
  2. Outlet boxes for fire alarm pull stations shall be mounted at a mounting height above finished floor that ensures that the operating handle of the initiating device is no higher than 48 inches from finished floor.
  3. Wall mounted fire alarm strobe or horn/strobe devices shall be mounted such that the entire lens is not less than 80 inches above finished floor. If ceiling heights allow, wall mounted appliances shall have bottom of lens a minimum of 80 inches but not more than 96 inches to the top of lens.
  4. Install outdoor fire alarm audible devices or fire alarm sprinkler flow bells at least 10 feet but not more than 12 feet above finished floor to center. Provide STI or other OWNER approved protective covers as required in plans.
  5. Voice evacuation speakers mounted indoors shall be mounted in ceiling space or if mounted on wall shall not be less than 10 feet to center above finished floor.
  6. Install clocks and speakers, in classrooms and offices, 7'-6" feet above finished floor. Unless otherwise indicated.
  7. In rooms other than places of assembly such as, but not limited to, multipurpose rooms, auditoriums, and libraries, clock outlets and speakers in classrooms and offices shall be mounted 8 feet above finished floors. Other assembly areas such as gymnasiums shall be mounted 10 to 12 feet above finished floor. Provide STI, or equal protective covers for clocks when required.
  8. Install fire alarm strobe lights 80 inches to bottom of light above finished floor.
  9. Install outside bells and yard light outlets 4 feet above second floor level for 2 or more story buildings, 12 inches below top plate level for one story buildings without covered porch or arcade, and 12 inches below covered porch and arcade ceilings.
  10. Install desk telephones, power receptacle outlets, and data outlets 15 inches above finished floor.
  11. Install panelboards and terminal cabinets 6 feet 6 inches from finish floor to top of cabinet.

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12. Install television outlets at a height corresponding to location of television monitor, or as indicated on plans.
13. The use of extension boxes shall be limited to not more than 1 times the original depth of junction box.

### **3.02 COVER PLATES**

- A. Provide a plate on each switch, plug, pilot light, data, interphone, public telephone, and television outlet, and on existing and reset outlets where so indicated or required. Plates shall be of stainless steel unless otherwise specified.
- B. Flush wiring device and signal system outlets indicated to be blank covered, shall be covered with blank stainless-steel plates. Flush lighting outlets to be blanked shall be covered with Wiremold 5736 steel covers, or equal, painted to match surrounding finish. Provide stainless steel covers to blank indicated or required surface-mounted outlets.
- C. In the following cases, and at required locations. Switch and receptacle plates shall be engraved with the device(s), or fixtures being controlled, or as indicated:
  1. Three-gang and larger gang switches in locations other than classrooms.
  2. Lock switches.
  3. Pilot switches.
  4. Switches so located that operator cannot see fixtures, or items of equipment controlled while his hand is on the switch.
  5. Switches not in same room with fixtures or items of unit heaters, air curtains, fly fans, etcetera.
  6. Receptacles operating at other than 120 V shall be identified with the operating voltage.
  7. Switches operating on 277 V shall be identified with the operating voltage.
  8. Where indicated on Drawings.
- D. Designations shall be as indicated on Drawings or as specified by Architect.
- E. Standard GFI cover plates shall be Pass & Seymour 4600, Raco 5028-0, or equal. GFI cover plates shall be provided with a CAM lock mechanism with two keys or a padlock hasp that does not protrude through the face of the cover and will allow the shank of locks keyed Corbin No. 60 keys.

### **3.03 IDENTIFICATION OF CIRCUITS AND EQUIPMENT**

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- A. Provide descriptive nameplates or tags permanently attached to switchboards, motor control centers, transformers, panelboards, circuit breakers, disconnect switches, starters, pushbutton control stations and other apparatus installed for operation or control of circuits, appliances, fire alarm control panel(s), fire alarm annunciator(s), power supplies, terminal cabinets, energy management control units, and Information technology system backbone and distribution equipment points.
- B. Provide nameplates of engraved laminated plastic, or etched metal. Submit Shop Drawings denoting dimensions and format to Architect before installation. Fasten to equipment with escutcheon pins, rivets, self-tapping screws, or machine screws. Self-adhering or adhesive backed nameplates are not permitted.
- C. Fasten tags to feeder wiring in conduits at every point where runs are broken or terminated, including pull wires in empty conduits. Indicate circuit, phase, and function. Tag branch circuits in panel boards and motor control centers. Tags may be manufactured of pressure-sensitive plastic or embossed self-attached stainless steel or brass ribbon.
- D. Provide circuit identification cards and cardholders in all panel boards. Cardholders shall consist of metal frame retaining a clear plastic cover permanently attached to inside of panel door. List of circuits shall be typewritten on a card. Circuit description shall include name or number of circuit's area and connected load.
- E. Junction and pull boxes shall have covers stenciled with box number when indicated on Drawings, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting with finish.
- F. Name shall be correctly engraved, with a legend indicating function or areas, when required by codes or indicated on Drawings.

### **3.04 PROTECTION**

- A. Protect Work of this section until Substantial Completion.

### **3.05 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

## **END OF SECTION**

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**SECTION 26-0519 - LOW-VOLTAGE WIRES (600 VOLT AC)**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Provisions of Division 01 apply to this section.
- B. Section Includes: Low-voltage wire, splices, terminations and installation.

**1.02 SUBMITTALS**

- A. Provide in accordance with Division 01.
- B. List of Materials: Submit a complete list of proposed materials.
- C. Shop Drawings: Provide detailed and dimensioned Shop Drawings indicating kind, weight and thickness of materials, insulation type, resistivity, conductivity, impedance, and conductance. Drawings shall contain sufficient information to assemble and install equipment at the Project site without further instructions.
- D. Prior to start of construction; provide letter from wiring and electrical cables manufacturer certifying that the products are qualified/ listed as low electromagnetic field products.

**1.03 SUBSTITUTIONS**

- A. Deviations/Substitutions from these requirements shall not be accepted without written approval from OWNER'S Design Standards Section and Maintenance and Operations Technical Unit. When deviating are proposed the following information shall be submitted:
  - 1. Substitution request form stating reasons and benefits to OWNER.
  - 2. OWNER'S approval shall be obtained for any equipment or materials substitutions.
  - 3. Proposed substitutions requests shall provide proof of compliance with OWNER'S requirements and applicable standards.
- B. Submittals must comply with contract general provisions.

**1.04 QUALITY ASSURANCE**

- A. Components and materials shall be listed and approved for the intended application by Underwriter's Laboratories (UL), or other Nationally Recognized Testing Laboratory (NRTL), and in compliance with applicable industry standards and codes.
- B. Wiring installation shall be performed under the supervision of state certified electricians. Contractor or Installer's electricians shall be certified in accordance with



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Labor Code sections 3099, and 3099.2 and section 209.0 of the California Code of Regulations.

- C. Contractor shall have adequate experience installing systems of similar size and complexity.
  - 1. Qualifications of Installer: Minimum five years of experience installing products and systems of similar scope and complexity.
  - 2. Installer shall have completed at least five projects of equivalent scope and complexity.
  - 3. Contractor shall have completed and commissioned a minimum of five service agreements that provide similar support services to those needed for this project.
  - 4. System startup and testing shall be performed under direct observation of the Project Inspector and OAR.
- D. The Project Inspector will observe installation of feeder cables. Notify the Project Inspector not less than two working days in advance of the proposed time of feeder installation.

### 1.05 WARRANTY

- A. Provide a one year labor warranty.
- B. Provide material warranty of no less than 10 years.
- C. Warranty period begins at substantial completion or project acceptance for beneficial occupancy.
- D. CONTRACTOR shall warranty all products and materials. Multiple warranty sources is not acceptable.

## PART 2 - PRODUCTS

### 2.01 WIRES

- A. Pressure cable connectors shall be pre-insulated 3M Scotchlok, Ideal Wing Nut, O-Z/Gedney or equal.
- B. Wires shall be single conductor type THHN or THWN insulated with polyvinyl chloride and covered with a protective sheath of nylon, rated at 600 volts. Wires may be operated at a maximum continuous conductor temperature in dry locations of 90 degrees C. and 75 degrees C. in wet locations. Wires and cables shall be listed by Underwriter's Laboratories (UL) Standard 83 for thermoplastic insulated wires and listed for installation in accordance with Article 310 of the California Electrical Code (CEC).
- C. Conductors shall be solid copper for 12 AWG and smaller conductors, and stranded copper for 10 AWG and larger conductors.

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- D. Conductors shall be insulated with PVC and sheathed with nylon.
- E. Wires shall be identified by surface markings indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol, type designations and optional rating. Indentations for lettering are not permitted.
- F. Wires shall be tested in accordance with the requirements of UL standard for types THWN and THHN.
- G. Conductors shall be solid Class B or stranded Class C annealed uncoated copper in accordance with UL standards, or another Nationally Recognized Testing Laboratory (NRTL).

### **2.02 STANDARDS**

- A. THWN/THHN wires shall comply with the following standards:
  - 1. UL 83 for thermoplastic insulated wires.
  - 2. UL 1063 for machine tool wires and cables.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Wires shall not be installed until debris and moisture is removed from conduits, boxes, and cabinets. Wires stored at site shall be protected from physical damage until they are installed and walls are completed.
- B. Wire-pulling compounds furnished as lubricants for installation of conductors in raceways shall be compounds approved and listed by UL, NRTL, or equal. Oil, grease, graphite, or similar substances are not permitted. Pulling of 2 AWG or larger conductors shall be performed with a cable pull machine. Any runs shorter than 50 feet are exempt. When pulling conductors, do not exceed manufacturer's recommended values
- C. At outlets for light, power, and signal equipment, pigtail splices with 8-inch circuit conductor leads for connection to fixtures, equipment, and devices.
- D. Pressure cable connectors, Yellow, Red, or Blue spring-loaded twist-on type, may be furnished in splicing number 8 AWG or smaller wires for wiring systems. Listed Push-in spring clamp wire connectors, Ideal In-Sure, or equal may be used in luminaires for fixture wiring.
- E. Joints, splices, taps, and connections to switchboard neutral, bonding or grounding conductors, conductors to ground busses, and transformer connections for wires 6 gage and larger shall be performed with high-pressure cable connectors approved for installation with copper conductors. Connectors shall be insulated with heavy wall heat shrink WCSM, or cold-applied roll-on sleeve RVS. Insulation level shall be a minimum of 600V and joints, splices, and taps shall be qualified to ANSI C 119.1, UL, NRTL, or equal listed mechanical pressure connections.

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- F. Connections to any bussing and high-pressure cable connectors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
- G. Connection of any bonding or grounding conductors shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
- H. Wire switchboards, panel cabinets, pull boxes, and other cabinets except public address, shall be neatly grouped and tied in bundles with nylon ties at 10-inch intervals. In switchboards, panels and terminal blocks, wires shall be fanned out to terminals. If bundles are longer than 24 inches, a maximum of nine current carrying conductors may be bundled together.
- I. Install conductor lengths with a minimum length within the wiring space. Conductors must be long enough to reach the terminal location in a manner that avoids strain on the connecting lug.
- J. Maintain the conductor required bending radius.
- K. Neutral conductors larger than 6 gage, which are not color identified throughout their entire length, shall be taped, painted white or natural gray, or taped white where they appear in switchboards, cabinet, gutters or pull boxes. Neutral conductors 6 gage and smaller shall be white color identified throughout their entire length.
- L. Fire alarm and clock wiring shall be continuous from terminal cabinets or from equipment to each device. Splices are not permitted between devices and/or terminal cabinets at junction and pull boxes. Wiring shall be terminated at terminal blocks or devices only.
- M. Wiring systems shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of feeder and branch circuit conductor's insulation resistance. The insulation of the conductors shall be tested prior to connections to any panelboards, switchboards, variable frequency drives, lighting control systems, ballasts, and wiring devices such as but not limited to GFI receptacles, TVSS receptacles, or equipment. Insulation testing of panelboards and switchboards shall be independently performed from the insulation testing of any conductors as specified in other sections of this specification.
  - 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of feeder conductors. Tests must be conducted with wires disconnected at both ends.
    - a. Provide calibration program records to assure the testing instrument to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
    - b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.

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- c. Test reports shall include the following:
  - 1) Identification of the testing organization.
  - 2) Equipment identification.
  - 3) Ambient conditions.
  - 4) Identification of the testing technician.
  - 5) Summary of project.
  - 6) Description of equipment being tested.
  - 7) Description of tests.
  - 8) Test results.
  - 9) Analysis, interpretation and recommendations.
2. Utilize the services of an approved independent testing laboratory or a qualified contractor's employee (Technician certified in accordance with ANSI/NETA ETT-2000 Standard for Certification of Electrical Testing Personnel) to perform megger time-resistance insulation testing of branch circuit conductors. Tests must be conducted with wires disconnected at both ends.
  - a. Test equipment and report requirements stipulated under paragraph 3.01.N.1 apply to branch circuit testing.
3. Tests shall be performed in the presence of the Project Inspector.
4. Insulation resistance shall not be less than 100 mega-ohms.

### **3.02 COLOR CODES**

A. General Wiring:

1. For phase and neutral conductors 6 gage or larger, permanent plastic-colored tape may be furnished to mark conductor end instead of coded insulation. Tape shall cover not less than 2 inches of conductor insulation within enclosure.
2. Color code conductor insulation as follows:

SYSTEM VOLTAGE		
Conductor	208Y/120	480Y/277
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Natural Gray

Neutrals shall be colored-distinguished if circuits of two voltage systems are used in the same raceway.

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3. Where two voltage systems are combined in an enclosure; CONTRACTOR shall apply a permanent color code label where the circuits originate.
- B. Signal Systems: Wires for signal systems shall be color-coded and installed under observation of the Project Inspector. Also, refer to Div. 27 & Div. 28 for specific requirements of the systems. Except where otherwise specified, color-coding shall be as follows:

<u>SYSTEM</u>	<u>COLOR CODE</u>
Clocks	Pink, Gray and Orange
Program Bells (some existing elementary schools)	White (Common)Black
Initiating Devices (Non-Addressable)	Red (+) and Black (-)
Program Bells (some existing secondary schools)	White (120 volt, common) Black (C.R. program) Blue (Shop program) Brown (Gym program) Yellow (Auditorium fire alarm)
Fire Alarm Horns	Pink (+) and Gray (-)
Fire Alarm Strobes	Orange (+) and Blue (-)
Un-Interruptible 24 Volt Power (Annunciator, Water Flow, and Audible Device)	Yellow (+) and White (-) Note: A single white wire may be common to both
Interruptible 24 Volt Power (4 wire smoke detectors, duct detectors)	Brown (+) and White (-) Note: A single white wire may be common to both
Switch-Leg Sprinkler Bell (Between water flow and audible device)	Violet (+) and White (-)
Door Holding Magnets (Non Power Limited)	Black (+) and White (-)

**3.03 FEEDER IDENTIFICATION**

- A. Feeder wires and cables shall be identified at each point the conduit run is broken by a cabinet, box, gutter, etc. Where terminal ends are available, identification shall be by means of heat shrink wire markers, which provide terminal strain relief. Markers shall be by Tyco Electronics, Panduit, Brady Perma-Sleeve, or equal. Identification in other areas shall be by means of wrap-around tape markers from Tyco Electronics, Panduit, Brady Perma-Code or equal. Markers shall include feeder designation, size, and description.

**3.04 TAPE AND SPLICE KITS****Low Voltage Wires - 260519**

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- A. Splices, joints, and connectors joining conductors in dry and wet locations shall be covered with insulation equivalent to that provided on conductors. Free ends of conductors connected to energized sources shall be taped. Voids in irregular connectors shall be filled with insulating compound before taping. Thermoplastic insulating tape approved by UL, NRTL, or equal for installation as sole insulation of splices shall be furnished and shall be installed according to manufacturer's printed specifications.

### **3.05 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

### **3.06 CLEANUP**

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

**END OF SECTION**

## **SECTION 26-0526 - GROUNDING AND BONDING**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Provide and install an effective grounding and bonding system.
- B. Related Requirements:
  - 1. Refer to related sections for their system grounding requirements.
  - 2. Division 01 - General Requirements.
  - 3. Division 26 – Electrical.
  - 4. Division 27 – Communications.
  - 5. Division 28 - Electronic Safety and Security.

#### **1.02 QUALITY ASSURANCE**

- A. Reference Standards:
  - 1. IEEE 142 Green Book.
  - 2. Underwriter's Laboratories (UL).
  - 3. California Electrical Code.
  - 4. Building Industry Consultant Services International (BICSI).
  - 5. EIA/TIA (Signal and power).
  - 6. Nationally Recognized Testing Laboratory (NRTL).

#### **1.03 SYSTEM DESCRIPTION**

- A. Equipment, components, or materials that enclose electrical conductors, or are likely to be energized by electrical currents shall be effectively grounded.
- B. Metal equipment parts such as switchboards, panelboards, metal enclosures, raceways, equipment grounding conductors, and earth grounding electrodes shall be effectively bonded into a continuous grounding path.
- C. Metallic systems or electrically conductive materials shall be effectively bonded to the building's grounding electrode system.

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- D. A separately derived AC system shall be grounded to the equipment grounding conductor and to a separate “made” electrode of building grounding electrode system.
- E. Provide effective electrical equipment bond continuity to all metal raceways and enclosures. Grounding shall be achieved through a code sized green insulated grounding conductor provided within each raceway.
  - 1. Each flexible conduit over six feet in length shall be provided with a green insulated grounding conductor of required size.
  - 2. Provide code sized equipment grounding conductor in all flexible conduits as required by CEC.
  - 3. The length of flexible conduit installations shall not be less than six feet.
  - 4. Effectively ground metal raceways and enclosures at each end.
- F. Cold water, or other utility piping systems, shall not be utilized as grounding electrodes. In addition to bonding to cold water pipe provide at least one of the following made grounding electrodes:
  - 1. A dedicated “made” electrode, fabricated of at least 20 feet of uncoated galvanized 1/2 inch diameter rebar encased by at least two inches of concrete, and placed next to the bottom of a concrete foundation, or footing in direct contact with earth. A welded extended portion shall surface at the location of the common grounding electrode bus bar and be extended by a 3/0 exothermic welded bare copper cable, or be welded directly to the bus. The exothermic weld shall be at least four inches above finished floor in a dry location. The main grounding electrode and associated grounding conductors shall be in an enclosure and in conduit.
  - 3. Concrete enclosed electrode, fabricated of at least 20 feet of No. 2 AWG, minimum size, bare copper conductor, encased by at least two inches of concrete, located within or near bottom of a concrete foundation, or footing, which is in direct contact with earth. Footing rebar shall be connected to copper wire with approved connectors.
  - 4. An external grounding electrode, as specified hereafter or as required by the CEC shall be installed and connected to foundation or footing rebar.
- G. Non-current carrying metal parts of high-voltage (1000 Volts or more) equipment enclosures, signal and power conduits, switchboard and panelboard enclosures, motor frames, equipment cabinets, and metal frames of buildings shall be permanently and effectively bonded to the grounding system. Provide a CEC sized equipment grounding conductor in every raceway.
- H. Metallic or semi-conducting shields and lead sheaths of cables operating above 1000 Volts shall be permanently and effectively grounded at each splice and termination.
- I. Neutral of service conductors shall be grounded as follows:

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1. Neutral shall be solidly grounded at only one point within the Project site for that particular service. Preferable location of grounding point shall be at the service switchboard, or main switch.
  2. Equipment and conduit grounding conductors shall be bonded to that grounding point.
  3. If other buildings or structures on the Project site are served from a switchboard or panelboard in another building, power supply is classified as a feeder and not as a service.
  4. Equipment grounding conductor shall be installed from switchboard to each individual building. At building, grounding conductor shall be bonded with power equipment enclosures, metal frames of building, etc., to "made" electrode for that building.
  5. Feeder neutrals shall be bonded at service entrance point only; neutrals of separately derived systems shall be bonded at the source only.
- J. If there is a distribution transformer at a building the secondary neutral conductor shall be grounded to "made" electrode serving the building.
- K. Within every building, the main switchboard or panelboard, shall be bonded to the cold water line. Metallic piping systems such as gas, fire sprinkler, or other systems shall be bonded to the cold water line.

### 1.04 SUBMITTALS

- A. Provide in accordance with Division 01.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Furnished yard boxes shall be precast concrete and shall be approximately 14 inches wide by 19 inches long by 12 inches deep or larger.
- a. Boxes shall be furnished with bolt-down, checkered, cast iron covers and cast-iron frames cast into the yard boxes.
  - b. Provide yard boxes with hinged Frame Locking Cover.
  - c. Approved products include Brooks No. 36 HFL, Jensen Precast, Oldcastle Precast, Western Precast, Kistner, or equal.
- B. External ground electrodes shall be copper-clad steel ground rods, minimum 3/4-inch diameter by ten feet long.
- C. Clamps and fittings used in ground boxes below grade shall be listed for direct burial.

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**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Grounding electrodes shall be installed in the nearest suitable planting area, where not otherwise indicated on Drawings, and each electrode shall terminate within a concrete yard box installed flush with finish grade. In planting areas, finish elevation of concrete yard boxes shall be two inches above planting surfaces.
- B. If concrete enclosed electrode is provided, grounding wire shall be terminated to a suitable copper plate with grounding lugs and must be enclosed in a raceway or box.
- C. Grounding rods shall be driven to a depth of not less than eight feet. Permanent ground enhancement material, (GEM) as manufactured by Erico Electrical Products, Loresco Powerset, Tessco Ultrafil or equal, shall be installed at each ground rod to improve grounding effectiveness. Install in accordance with manufacture's installation instructions.
- D. Grounding electrodes shall provide a resistance to ground of not more than 25 ohms.
- E. When installing grounding rods, if resistance to ground exceeds 25 ohms, two or more rods connected in parallel, or coupled together shall be provided to meet CEC grounding resistance requirements.
- F. Ground rods shall be separated from one another by not less than ten feet.
- G. Parallel grounding rods shall be bonded together with listed fittings and grounding conductors in galvanized rigid steel conduit, buried not less than 12 inches below finish grade.

**3.02 TESTING**

- A. Provide the services of an approved independent testing laboratory to test grounding resistance of "made" electrodes, ground rods, bonding of building steel, water pipes, gas pipes and other utility piping. Tests shall be performed as follows:
  - 1. Visually and mechanically examine ground system connections for completeness and adequacy.
  - 2. Perform fall of potential tests on each ground rod or ground electrode where suitable locations are available per IEEE Standard No. 81, Section 8.2.1.2. Where suitable locations are not available, measurements will be referenced to a known dead earth or reference ground.
  - 3. Perform the two-point method test per IEEE No. 81, Section 8.2.1.1 to determine ground resistance between ground rod and building steel, and utility piping - such as water, gas and panelboard grounds. Metal hand railings at building entrances and at handicapped ramps shall also be tested.
  - 4. Test shall be performed in the presence of the Inspector.

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- B. Submit 3 copies of test results to the Architect. Test results shall be submitted on an official form from the independent testing laboratory recording Project location, test engineer, test conditions, test equipment data, ground system layout or diagram, and final test results.

### **3.03 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

### **3.04 CLEANUP**

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

**END OF SECTION**

## SECTION 26-0533 - RACEWAYS, BOXES, FITTINGS, AND SUPPORTS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Raceways and wire ways.
  - 2. Conduit installation.
  - 3. Underground requirements.
- B. Related Requirements:
  - 1. Section 26 05 00: Common Work Results for Electrical.
  - 2. Section 26 05 13: Basic Electrical Materials and Methods.
  - 3. Division 27: Communications.
  - 4. Division 28 - Electronic Safety and Security.
- C. Applicable Standards and Codes.
  - 1. EIA/TIA 569 Standards.
  - 2. National American Standards Institute (ANSI).
  - 3. National Electrical Manufacturer's Association (NEMA).
  - 4. Nationally Recognized Testing Laboratory (NRTL).
  - 5. California Electrical Code (CEC).
  - 6. Uniform Building Code (UBC).
  - 7. Underwriters Laboratory (UL).

#### 1.02 SUBMITTALS

- A. Materials List: Provide in accordance with Division 01.

### PART 2 - PRODUCTS

#### 2.01 RACEWAYS

- A. Conduit Materials:
  - 1. Metallic conduit, and tubing shall be manufactured under the supervision of an UL, or another NRTL factory inspection and label service program. Each ten-foot length of conduit and tubing shall bear the UL or another NRTL label and manufacturer's name.
  - 2. Rigid metallic conduit shall be rigid steel, heavy wall, mild steel, zinc-coated, with an inside and outside protective coating manufactured in accordance with ANSI C 80.1. Couplings, elbows, bends, conduits, bushings and other fittings shall be the same materials and finish as the rigid metallic conduit. Fittings, connectors, and couplings shall be threaded type, manufactured in accordance with ANSI C 80.1 and UL 6.

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3. Electrical metallic tubing shall be steel tubing, zinc-coated with a protective enamel coating inside, manufactured in accordance with NEMA C 80.3. Fittings, couplings, and connectors shall be gland compression type, set screw couplings and connectors not permitted. All parts shall be manufactured in accordance with NEMA C80.3 and UL 6A Electrical metallic tubing is designated hereinafter as EMT. Steel and rain tight fittings shall be approved and listed for the intended application.
  4. Flexible steel conduit shall be of flexible interlocking strip construction with continuous zinc coating on strips, manufactured in accordance with UL 1.
    - a. Connectors and couplings shall be required fittings of the type, which threads into convolutions of flexible conduit.
  5. Liquid-tight flexible metal conduit shall be galvanized heavy wall, flexible locked steel strip construction, UV rated, with smooth moisture and oil-proof, abrasion-resistant, extruded plastic jacket. Connectors shall be as required for installation with liquid-tight flexible conduit and shall be installed to provide a liquid-tight connection.
  6. Non-metallic conduit shall be rigid PVC electrical conduit extruded to schedule 40 dimensions of Type II. Grade 1 high impact, polyvinyl chloride, sweeps, couplings, reducers and terminating fittings shall be listed under the UL, or another NRTL, and shall bear the manufacturer's listed marking.
  7. Multi-cell raceway shall be four inch PVC, Type 40, UL or another NRTL listed for underground use with optical fiber and signal system cables. Raceway shall be furnished with 3-1/2 inch factory installed inner ducts with required internal spacers, and required couplers, sweeps, and end bells. Multicell raceway shall be Carlon Multigard, or District approved equal.
  8. Metal Clad (MC) cable system is not allowed.
- B. Sleeves for Conduits: Sleeves shall be adjustable type by Carlon, U.S. Plastic, PEP Plastic or equal.
- C. Where conduit enters a building through a concrete foundation below grade, or ground water level, or where it is necessary to seal around a conduit where it passes through a concrete floor or wall, provide O-Z/Gedney Type FSK Thru Wall and Floor Seal, equivalent Cooper Crouse Hinds Thru-Wall, Legrand Thru-Wall, or equal.
- D. Expansion Joints-Seismic Separations between building(s) and other locations as indicated on drawings:
1. Provide Thomas & Betts XJG-TB, O-Z/Gedney. type AX with bonding strap and clamps, Cooper XJGD or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z/Gedney type EX, Cooper XJGD, or equal. Provide O-Z/Gedney type AXDX, or equal combination deflection/expansion fittings at all seismic separations. Provide manufacture's internal and external bonding jumpers at all locations. Liquid-tight metal conduit or flexible metal conduit shall not be approved at expansion joints, separations between buildings or seismic separations.
  2. Provide expansion fittings at intervals not exceeding 100 feet in conduits exposed to direct sunlight. Fittings may be installed in the conduit run or

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where conduit attaches to junction or pull boxes. OZ/Gedney type AX, TX or EXE series, or equivalent by Thomas and Betts, Crouse-Hinds or approved equal.

E. Conduit Seal Fittings:

1. Provide conduit seal fittings where indicated on the Drawings. Conduit seals shall be of rigid galvanized steel. Seals in horizontal conduit installations shall be Thomas & Betts EYS, Appleton Type ESU, Crouse Hinds Type EYS, or equal. Seals in vertical conduit installations shall be Thomas & Betts EYD, Appleton Type SF, Crouse Hinds Type EYD, or equal, with continuous drain. When installing conduit seals make provision for percent fill space reduction in accordance with CEC.
2. Install sealing compound after wire has been installed. Ensure drain is not blocked in vertical seals when installing compound. Where conduit seals are installed in hazardous area applications, there shall be no conduit coupling, fitting, etc., between seal and boundary of hazardous area.

F. Penetration in Fire-Rated Structures: Provide 3M, or equal, sealant and fire barriers for installing fire-rated seals around penetrations through floors, walls, and elevator hoistways. Fire stop system must be UL, or another NRTL listed, and classified for through-penetration applications of metallic conduits and busways.

G. Pull Wires: Install 1/8 inch polypropylene cords in empty or spare conduits.

**PART 3 - EXECUTION**

**3.01 CONDUIT INSTALLATION**

A. General Requirements:

1. Provide complete and continuous systems of rigid metallic conduit, outlet boxes, junction boxes, fittings and cabinets for systems of electrical wiring including lighting, power, and signal systems, except as otherwise specified.
2. EMT may be installed in interior concealed applications and in areas approved by owner. EMT shall not be installed in concrete, directly buried underground, outdoors, in boiler rooms, elevator pits, or where subject to damage.
3. Within buildings, flexible steel conduit may be installed instead of rigid steel conduit where permitted by code. Flexible steel conduit shall be installed:
  - a. For continuous lengths not exceeding more than 50 feet between pull points (pull boxes, outlet boxes, etcetera).
  - b. With no maximum total raceway length located within a building interior when the flex is located in concealed locations.
4. Flexible Steel conduit shall not exceed 1-1/2 inches in size.
5. Liquid-tight flexible steel conduit shall only be installed, except where otherwise specified, for final connection of motor terminal boxes, shop equipment, cafeteria equipment, HVAC equipment and other equipment, or for frequent interchange, and shall be of sufficient length, not exceeding 36 inches, to permit full travel or adjustment of motor on its base. Liquid-tight

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flexible conduit shall not be used for equipment not requiring adjustment or frequent interchange.

6. Connectors for flexible metal conduit shall be made of steel, and of the types which threads into convolutions of conduit. Connectors for watertight flexible metal conduit shall be as required for installation and shall be installed to provide a watertight connection.
7. Exposed conduit shall be installed vertically and horizontally following the general configuration of the equipment, using cast threaded hub conduit fittings where required and shall be clamped to equipment with suitable iron brackets and one hole pipe strap.
8. If connection is from a flush wall-mounted junction box, install an approved extension box.
9. Underground feeder distribution conduits for systems may be non-metallic conduit instead of rigid conduit except where otherwise specified or indicated.
10. Conduit shall be concealed unless otherwise indicated. Conduits exposed to view, except those in attic spaces and under buildings, shall be installed parallel or at right angles to structural members, walls, or lines of building. Conduits shall be installed to clear access openings.
11. Bends or offsets will not be permitted unless absolutely necessary. Radius of each conduit bend or offset shall be as required by ordinance. Bends and offsets shall be performed with standard industry tools and equipment or may be factory fabricated bends or elbows complying with requirements for radius of bend specified. Heating of metallic conduit to facilitate bending is not permitted. Public telephone conduit bends and offsets shall be provided with a radius which is not less than ten times trade size of conduit unless otherwise permitted. Refer to underground installation, specified in this section, for radius of bends and offsets required for underground installations.
12. Running threads are not permitted. Provide conduit unions where union joints are necessary. Conduit shall be maintained at least six inches from covering of hot water and steam pipes and 18 inches from flues and breechings. Open ends of conduits shall be sealed with permitted conduit seals during construction of buildings and during installation of underground systems.
13. Expansion Joints/Seismic Separations/Separations between buildings/Locations Indicated: Provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type AX with bonding strap and clamps. Crouse Hinds XJGD, or equal. At exterior locations, provide Thomas & Betts XJG-TB, O-Z Electrical Mfg. Co. Inc. Type EX, Crouse Hinds XJGD, or equal. Provide Crouse Hinds, Thomas & Betts, or O-Z Electrical Mfg. Co. Type AXDX, or equal Combination Deflection/Expansion Fittings at all seismic separations. Provide manufactures internal and external Bonding Jumpers at all locations. Liquid-tight flexible conduit shall not be approved at expansion joints or seismic separations.
14. Where conduits are terminated in groups at panelboards, switchboards, and signal cabinets, etc., provide templates or spacers to fasten conduits in proper

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position and to preserve alignment. Conduits terminating at signal cabinets shall only enter cabinets in the following locations:

- a. Conduits entering top, side, and bottom of cabinets shall be aligned in a single row, centered two inches from rear of cabinet.
  - b. Conduits entering back of cabinet shall be aligned in a single row centered two inches from top of cabinet.
  - c. Conduits shall not be spaced closer than three inches on centers.
15. Conduits above metal lath ceilings shall be rigidly suspended with pipe hangers or pipe racks or shall be secured to superstructure with factory fabricated pipe straps. Conduits in metal lath or steel stud partitions shall be tied to furring channels or studs. In ceiling spaces and in partitions, tie wires shall be spaced not more than 5 feet apart, shall fasten conduit tight against channels and studs at point of tie and shall not support any of conduit weight. Tie wire shall be 16 gage galvanized double annealed steel.
  16. Where auxiliary supports, saddles, brackets, etc., are required to meet special conditions, they shall be fastened rigid and secure before conduit is attached.
  17. Conduit in ceiling spaces, stud walls, and under floors, shall be supported with factory fabricated pipe straps or shall be suspended with pipe hangers or pipe racks. Pipe straps shall be attached to and shall fasten conduit tight at point of support against ceiling and floor joists, rafters, and wall studs, or 2" X 4" headers fitted between joists or wall studs.
  18. Conduits installed on exposed steel trusses and rafters shall be fastened with factory fabricated conduit straps or clamps, which shall fasten conduit tight against supporting member at point of support.
  19. Conduits installed under buildings shall be strapped with factory fabricated conduit straps to underside of concrete floor or joists, or wood floor joists, or shall be suspended with pipe hangers or pipe racks. Conduits under building are not permitted to be placed directly on grade; they shall be suspended from building or shall be buried below surface or ground. 1-1/4 inch and larger conduits under buildings shall be installed with conduit hangers or racks.
  20. Pipe hangers for individual conduits shall be factory fabricated. Steel rods shall be 3/8 inch for two-inch conduit hangers and smaller and shall be 1/2 inch for 2 1/2-inch conduit hangers and larger.
  21. Pipe racks for groups of parallel conduits and for supporting total weights not exceeding 500 pounds shall be trapeze type and shall consist of a cross channel, Steel City Kindorf B-900, Unistrut P-1000, equivalent Cooper B-Line or equal, suspended with a 3/8 inch minimum diameter steel rod at each end. Rods shall be fastened with nuts, top and bottom to cross-channel and with square washers on top of channel. Conduits shall be clamped to top for cross-channel with conduit clamps, Steel City Kindorf C-105 or Unistrut P-1111 through P-1124, equivalent Cooper B-Line, or equal. Conduits shall not be stacked one on top of another, but a maximum of two tiers may be on same rack providing an additional cross-channel is installed. Where a pipe rack is to be longer than 24 inches, or if the supported weight exceeds 500 pounds, submit Shop Drawings of installation to the Architect for review.

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22. Conduits suspended on rods more than two feet long shall be rigidly braced to prevent horizontal motion or swaying. Installation shall meet zone 4 seismic requirements.
23. Factory fabricated pipe straps shall be one or two-hole formed galvanized clamps, heavy-duty type, except where otherwise specified.
24. Hangers, straps, rods, or pipe supports under concrete shall be attached to inserts set at time concrete is placed, or with approved concrete anchors. Under wood, install bolts, lag bolts, or lag screws; under steel joists or trusses, install beam clamps. Contractor shall submit size of anchors, bolts, screws, and installation method to Architect for approval prior to start of any work.
25. Conduits shall be supported at intervals required by code, but not to exceed ten feet. One inch and smaller exposed conduits shall be fastened with one-hole malleable iron straps. Perforated straps and plumber's tape is not permitted for the support of conduits.
26. Conduits stubbed up through a roof or an arcade shall be flashed with a waterproof flashing. Refer to Division 07 for additional requirements.
27. Bushings and locknuts for rigid steel conduit shall be steel threaded insulating type. Setscrew bushings are not permitted.
28. Flex conduits shall be cut square and not at an angle.
29. Routing of conduits may be changed providing length of any conduit run is not increased more than ten percent of the length indicated on Drawings.

### B. Underground Requirements:

1. Conduits and multicell raceways installed underground shall be entirely encased in three inch thick concrete on all sides, except where otherwise specified. Provide required spacers to prevent any deflection when concrete is placed and to preserve position and alignment. Conduits and raceways shall be tied to spacers. Anchors shall be installed to prevent floating of conduits and raceways during placing of concrete. Provide red colored concrete to encase conduits of systems operating above 600 volts.
2. Underground conduits and raceways shall be buried to a depth of not less than 24 inches below finished grade to top of the concrete envelope, unless otherwise specified.
3. Assemble sections of conduit with required fittings. Cut ends of conduit shall be reamed to remove rough edges. Joints in conduits shall be provided liquid-tight. Bends at risers shall be completely below surface where possible.
4. Conduits and raceways in a common trench shall be separated by at least three inches of concrete. Electrical power and/or lighting conduit runs installed in a common trench with conduits containing signal system wiring such as public address, telephone, intrusion detection, fire alarm, television, computer networking, and clock systems shall maintain a separation of a minimum of six inches from these types of signal system conduits and raceways. Electrical power, lighting and signal conduits and raceways installed in a common trench with other utility lines such as gas, water, sewer and storm lines shall maintain 12 inches separation from these types of utility lines.

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5. The Inspector will observe underground installations before and during concrete placement. A mandrel shall be drawn through each run of conduit in presence of the Inspector before and after placing concrete. Mandrel shall be six inches in length minimum, and have a diameter that is within 1/4 inches of diameter of conduit to be tested.
  6. Non-metallic conduit installations shall comply with following additional requirements. Joints in PVC conduit shall be sealed by means of required solvent-weld cement supplied by conduit manufacturer. Non-metallic conduit bends and deflections shall comply with requirements of applicable electrical code, except that minimum radius of any bend or offset for conduits sized from 1/2 inch to 1 1/2-inch inclusive shall not be less than 24 inches. Bends at risers and risers shall be PVC-coated rigid steel conduit. Radius of curve of bends or offsets in non-metallic conduit for public telephone system shall be not less than ten times trade size of conduit, unless otherwise specifically permitted.
  7. Furnish and install a six-inch wide, polyethylene, red underground barrier type 12 inches above full length of concrete reading, "CAUTION ELECTRIC LINE BURIED BELOW".
  8. Underground conduit systems provided for utility companies shall be furnished to meet the requirements of the utility companies requiring service.
  9. Protect inside of conduit and raceway from dirt and rubbish during construction by capping openings.
  10. Add bell-end bushings for conduit stub-up including underground entries to pull boxes, and manholes. Under floor standing switchboards and motor control centers provide a four-inch galvanized nipple with ground bushing.
  11. Underground conduit for systems operating above 600 volts shall be a minimum size of four inches.
  12. At portable classroom all stub ups shall be installed with a coupling flush to finish grade.
  13. Underground conduits and raceways shall be swabbed prior to wire pull.
- C. Rooftop conduit shall be supported from channels, stands, clamps, trapezes, rollers, or structures mounted on 100% rubber, UV resistant rooftop supports with reflective strips, Dura-Blok, or equal. Roller type supports shall be provided below and above conduit to prevent its dislodgement. Bottom of conduits shall clear the roof surface by 10 inches.
1. At PVC roofing provide walk tread, polyester reinforced, UV resistant, with surface embossment at rooftop supports. Heat welding of walk pads shall only be done by manufacturer certified installers.
    - a. Sika-Sarnafil and Carlisle: Walk tread shall be no more than one inch larger than the plan area of the pipe support blocks and adhered to the roof membrane with Sika 1A or Carlisle Universal Single-Ply sealant, as applicable.
    - b. Johns Manville: Walk tread shall be installed under the pipe support blocks and adhered to the blocks, if possible, and left loose laid on

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top of the PVC roof system. Walk-pad shall have a minimum of 4 inches of material past perimeter on all 4 sides of block.

2. Built-up roofing: Provide APP granulated modified torch-down at each pipe support block. Torch-down shall extend 2 to 4 inches beyond the edges of the block and adhered by torch application over existing cap sheet membrane. This work shall be performed by a certified roofer.

**D. General Installation Requirements for Computer Network System Conduits:**

1. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Drawings shall not be scaled to determine position and routing of wireways, drops, and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place and must be ascertained in the field before start of Work.
2. The maximum pulling tensions of the specified cables shall not be exceeded and proper radius of cable bends shall be maintained.
3. For computer network wiring, conduit types shall be limited to rigid metal conduit, electrical metallic tubing, schedule 40 PVC, multi-cell raceways, and flexible metallic conduit for lengths less than six feet.
4. Interior section of conduit run shall be not longer than 100 feet and shall not contain more than two bends of 90 degrees between pull points or pull boxes.
5. The inside radius of a conduit bend shall be at least six times the internal diameter of the conduit. When the conduit size is greater than two inches, the inside radius shall be at least ten times the internal diameter of the conduit. For fiber-optic cable, the inside radius of a conduit bend shall be at least ten times the internal diameter of the conduit.
6. Conduit shall be sized in accordance with Table 4.4-1 of EIA/ TIA 569 standard.
7. Splicing or terminating cables in pull boxes is not permitted.
8. For indoor application, a pull box shall be provided in conduit run where:
  - a. The length is over 100 feet.
  - b. There are more than two bends of 90 degrees.
  - c. There is a reverse bend in the run.
9. Boxes shall be provided in a straight section of conduit and shall not be installed in lieu of a bend. The corresponding conduit ends are to be aligned with each other. Conduit fittings shall not be installed in place of pull boxes.
10. Where a pull box is provided with raceways, pull box shall comply with the following:
  - a. For straight pull-through, provide a length of at least eight times the trade-size diameter of the largest raceway.
  - b. For angle and U-pulls:

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- 1) Provide a distance between each raceway entry inside the box and the opposite wall of the box of at least six times the trade-size diameter of the largest raceway, this distance being increased by the sum of the trade-size diameters of the other raceways on the same wall of the box.
  - 2) Provide a distance between the nearest edges of each raceway entry enclosing the same conductor of at least:
    - a) Six times the trade-size diameter of the raceway; or
    - b) Six times the trade-size diameter of the larger raceway if they are of different size.
    - c) For a raceway entering the wall of a pull box opposite to a removable cover, provide a distance from the wall to the cover of not less than the trade-size diameter of the largest raceway plus six times the diameter of the largest conductor.
11. Drawings generally indicate Work to be installed, but do not indicate all bends, transitions of special fittings required to clear beams, girders or other Work already in place. Investigate conditions where conduits and wireways are to be installed, and furnish and install required fittings.
- E. Slabs on Grade:
1. Unless specifically reviewed by the Architect and DSA, conduits 1 ¼-inches and larger are not permitted to be installed in structural concrete slabs. Where conduits are permitted, and are installed in concrete slabs on grade, slabs shall be thickened at bottom where conduits occur to provide three inches of concrete between conduit and earth. Required excavation shall be part of the Work of this section.
  2. If concrete slab is five inches or more in thickness with a moisture barrier plastic sheet between earth and slab, one inch and smaller conduits shall be installed in the slab with a minimum of one inch concrete between earth and conduit.
- F. Concrete Walls, Beams, and Floors: Provide sleeves where conduits pierce concrete walls, beams, and floors, except floor slabs on grade. Sleeves shall provide 1/2 inch clearance around conduits. Sleeves shall not extend beyond exposed surfaces of concrete and shall be securely fastened to forms. Where conduits pass through walls below grade, seal with required sealant and backer materials between conduit and sleeve to provide a watertight joint. Sealant shall be as indicated in Section 07 9200: Joint Sealants.

### **3.02 STUBS**

- A. Panelboard: Install two one inch conduits from each flush mounted panelboard to access under floor space and to access above ceiling space where these conditions occur. Cap conduits with standard galvanized pipe caps.
- B. Floor: At points where floor stubs are indicated in open floor areas, for connections to machines and equipment, conduits shall be terminated with couplings, tops flush with finished floor. Stubs shall extend above couplings the indicated distance. Where

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capped stubs are designated, couplings shall be closed with cast iron plugs with screw drive slots.

C. Underground:

1. Underground conduit stubs shall be terminated at locations indicated, and shall extend five feet beyond building foundations, steps, arcades, concrete walks and paving. Rigid metallic conduit stubs and non-metallic conduit stubs shall be capped by installing a coupling flush in end wall of concrete encasement and plugging with a permitted plug. Project record drawings shall indicate location of ends of underground conduit stubs fully dimensioned and triangulated with reference to buildings or permanent landmarks. These dimensions, including depth below finished grade, shall be marked on project record drawings in presence of the Inspector before backfilling trench. Where extending existing concrete encased stubs, clean, chip and wire brush end of existing concrete and brush on a heavy coat of neat cement paste or epoxy bonding agent.
2. Over ends of individual underground conduit stubs or groups of conduit stubs, install four-inch by 18-inch deep PVC filled with concrete, flush with finished grade in asphaltic concrete or lawns, and two inches above finished grade in planting areas. Cast a three-inch by three-inch brass plate engraved "ELECT" flush in top of concrete. Secure plate to concrete with brass dowels or as indicated on drawings.

### 3.02 PROTECTION

- A. Protect the Work of this section until Substantial Completion.

### 3.03 CLEANUP

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

**END OF SECTION**

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**SECTION 26-0800 - ELECTRICAL SYSTEMS COMMISSIONING**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Section Includes:
  - 1. General requirements for Commissioning (Cx) of lighting systems components, lighting controls and HVAC systems line voltage interconnection components, including installation, start-up, testing and documentation according to construction documents and Commissioning Plan (CxP).
  - 2. Standard procedures for the execution of commissioning work shall be in conformance with Division 1, Section 01 91 13 General Commissioning Requirements. Coordinate work with the Commissioning Services Provider (CxSP).

**1.02 RELATED REQUIREMENTS**

- A. Division 01 – General Requirements.
- B. Section 01 91 13: General Commissioning Requirements.
- C. Section 01 79 00: Maintenance and Operations Staff Demonstration and Training.
- D. Section 23 80 00: Mechanical Equipment.
- E. Section 23 08 00: Mechanical Systems Commissioning.
- F. Section 23 09 23: Mechanical Environmental Control and Energy Management Systems.
- G. Section 23 08 13: Mechanical Environmental Controls and Energy Management System Commissioning.
- H. Section 26 05 00: Common Work Results for Electrical.
- I. Section 26 05 13: Basic Electrical Materials and Methods.
- J. Section 26 05 26: Grounding and Bonding.
- K. Section 26 05 19: Low Voltage Wires (600 Volt AC).
- L. Section 26 05 86: Motors and Drives.
- M. Section 26 24 19: Motor Control Center and Motor Control Devices.
- N. Section 26 50 10: Solid State Lighting.
- O. Section 26 09 23: Lighting Control Systems.

**1.03 REFERENCES**

- A. Applicable codes, standards, and references: inspections and tests shall be in accordance with the following applicable codes and standards:
  - 1. National Electrical Testing Association – NETA.
  - 2. National Electrical manufacturer's Association – NEMA.
  - 3. American Society for Testing and Materials – ASTM.
  - 4. Institute of Electrical and Electronic Engineers – IEEE.

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5. American National Standards Institute – ANSI.
6. National Electrical Safety Code – NESC.
7. California Building Code – CBC.
8. California Electrical Code – CEC.
9. California Green Building Standards Code (CalGreen).
10. Conglomerate for High Performance Schools (CHPS).
11. Insulated Power Cables Engineers Association – IPCEA.
12. Occupational Safety and Health Administration – OSHA.
13. National Institute of Standards and Technology – NIST.
14. National Fire Protection Association – NFPA.
15. California Electrical Code.
16. ANSI/NFPA 70B – Electrical Equipment Maintenance.
17. NFPA 70E – Electrical Safety Requirements for Employee Work Places.
18. ANSI/NFPA 101– Life Safety Code.

### 1.04 SUBMITTALS

- A. Submittals shall include the following:
1. Submit required Cx submittals in accordance with Division 1 Specification Sections.
  2. Copy of the Architect's reviewed and accepted submittals to the CxSP via the OAR.
  3. List of team members who will represent the CONTRACTOR in the Pre-functional Equipment Checks and Functional Performance Testing, at least two weeks prior to the start of Pre-functional Equipment Checks.
  4. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of OWNER-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of OWNER to keep Warranty in force, clearly defined.
  5. Detailed manufacturer's recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by CONTRACTOR's specific procedures, and Pre-functional Tests, at least four weeks prior to the start of Pre-functional Performance Tests.
  6. After facility's commission is complete, submit completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

### 1.05 MEETINGS, SEQUENCING AND SCHEDULING

- A. Meetings: Attend (Cx) meetings as required under Section 01 91 13 and the Cx Plan.

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- B. Sequencing and Scheduling: The work described in this Section shall begin only after work required in related Division 26 Sections has been successfully completed, and tests, inspection reports and Operation and Maintenance manuals required in Division 26 Sections have been submitted and approved. The start-up and Pre-functional Equipment Checklists shall be completed and submitted to the OWNER's Authorized Representative (OAR) prior to the functional performance tests. Refer to the project's Cx Plan for more details.
  - 1. Coordinate electrical work with the work of other trades prior to scheduling of any Cx procedures.
  - 2. Coordinate the completion of electrical testing, inspection, and calibration prior to start of Cx activities.
  - 3. Cx activities shall be scheduled in accordance with project's Cx plan.

#### **1.06 QUALITY CONTROL**

- A. Comply with OWNER's Quality Control Specifications, Sections 01 45 16 – 01 45 19, as applicable.
- B. Incorporate manufacturer's recommended Cx procedures for the systems and equipment to be commissioned under this Section.

### **PART 2 - PRODUCTS**

#### **2.01 TEST EQUIPMENT**

- A. Equipment to be utilized in the commissioning process shall meet the following requirements:
  - 1. Provide test equipment as necessary for the equipment and systems to be commissioned.
  - 2. Provide testing equipment and accessories that are free of defects and certified for use.
  - 3. Provide testing equipment with current calibration labels per NIST Standards.
  - 4. Testing equipment shall be UL Listed.

### **PART 3 – EXECUTION**

#### **3.01 COMMISSIONING PROCESS REQUIREMENTS**

- A. Work to be performed prior to commissioning:
  - 1. Complete all phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.
  - 2. Start-up services required to bring each system into full operational state and ready for functional performance testing:
    - a. Completion of authorized manufacturer representative's start-up procedures and recommendations.
      - 1. Provide Manufacturer's start-up completed forms.
    - b. Completion of pre-functional checklists.
    - c. Copy of required manufacturer and field testing.

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- d. Motor rotation check.
  - e. Control sequences of operation.
  - f. Full and partial load performance.
3. If modifications or corrections to the installed systems are required to bring the system(s) to acceptance levels due to CONTRACTOR's incorrect installation or defective materials, such modifications or corrections shall be made at no additional cost to the OWNER.
4. Functional tests shall not start until each system is complete and the above items have been documented and submitted to the Engineer of Record, Cx Services Provider and OWNER for review.
- B. Pre-commissioning Responsibilities: Inspection, calibration and testing of the equipment and devices necessary to commission the following systems:
  1. Electrical Lighting Systems.
  2. Lighting Controls.
  3. HVAC line voltage electrical components.
  4. Line voltage interface of Environmental Controls and Energy Management System with other systems.
  5. Photovoltaic Systems.
- C. Commissioning Process Requirements: Refer to Section 01 91 13 General Commissioning Requirements, related sections and Cx Plan for information on meetings, start-up plans, Pre-Functional and Functional Performance Testing (FPT), operations and maintenance data, and other Commissioning activities.

### 3.02 PREPARATION

- A. Provide certified electricians and/or qualified personnel as required with adequate tools and equipment necessary to perform Cx activities.
- B. Provide all equipment required for the commissioning of equipment and systems indicated in article 3.01.B.
- C. Provide certified testing agency personnel or report(s) as required in the Cx Plan.

### 3.03 TESTING

- A. Testing documentation shall include the following minimum information:
  1. Test number.
  2. Equipment used for the test, with manufacturer and model number and date of last calibration.
  3. Date and time of the test.
  4. Indication of whether the record is the first commissioning test, or a retest following correction of a previously identified issue.
  5. Identification of the system, subsystem, assembly, or equipment.
  6. Conditions under which the test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of the test.

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7. Systems and assemblies test results, performance and compliance with contract requirements.
  8. Issue number and description of corrected issue that prompted retesting.
  9. Name and signature(s) of witnesses and the person(s) who performed the test(s).
- B. Test lighting and controls systems to verify performance, operation, functionality, light levels, energy usage, and compliance with construction documents.
1. Start up, test and document results under the observation of the CxSP.
  2. Execute the Functional Performance Test (FPT) under the observation of the CxSP.
  3. Provide completed and signed FPTs to CxSP for inclusion in the commissioning report.
  4. Functions and Testing Conditions:
    - a. Occupancy sensors and timer controls for lighting:
      - 1) Verify that specified functions and features are set up, debugged and fully operable at time of test.
      - 2) Verify that occupant override feature functions as intended in the contract documents.
      - 3) Verify that sensors response times/durations are set properly.
      - 4) Test the sequence of operation for features and modes and confirm that adjustable times match the design specifications and contract documents.
      - 5) Verify that sensors are located per manufacturer's recommendations.
    - b. Electric lighting dimming, photocells and controls:
      - 1) Test the dimming controls during daytime when conditions are such that controls should be dimming electric lighting.
      - 2) Verify that amperage changes in light fixtures are proportional to external light changes. Verify that dimmed light levels uniformity at the specified work plane remain within specified limits.
      - 3) Verify that delays and ramp times are set and functioning so that the speed of change of light fixture output is slow enough to not bother occupants, and in compliance with the specifications.
      - 4) Verify that dimming does not cause lower than specified light levels in adjacent "non-dimmed" spaces.
      - 5) Verify that the controls and sensors cannot be easily overridden or disabled by occupants.
      - 6) Verify that dimming systems in places of assembly are interfaced with the Central Fire Alarm system.
      - 7) Verify that dimmed lighting in these areas shall come back to full bright during a fire alarm or emergency condition.
    - c. Illumination Levels, Night Conditions:

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- 1) Verify that lighting throughout the building is operating automatically.
    - 2) Test with doors closed (to simulate actual occupancy) and after finishes are complete.
  - d. Illumination Levels, Day Conditions:
    - 1) Verify that lighting levels comply with average maintained foot-candle levels shown on plans.
    - 2) Verify that lighting throughout the building is operating automatically.
    - 2) Test with doors closed (to simulate actual occupancy), after finishes are complete, and room is furnished.
    - 3) Test at different times during the day, or under OWNER-approved simulated conditions, to ensure proper system response and to determine that lighting levels are within specified requirements.
    - 4) In classrooms and educational spaces test the system for the different pre-determined settings. Quiet time, AV mode, all on/off, up/down dimming, and standard operations.
  - e. Lighting Power Density: Verify building lighting power density. Perform the test with interior lighting turned on and any manual or automatic controls temporarily overridden. Provide statement of compliance with 100% design energy report. Measurements shall be taken at least one minute after lights are turned on.
  - f. Emergency Lighting System: Verify that the system operates automatically under any condition, without human intervention, and that it resets back to normal operations after the power failure or emergency condition is over or cleared.
5. Acceptance Criteria:
- a. Lighting Controls: For the conditions, sequences and modes tested; dimming, occupancy, photocell, and timing controls, integral components and related equipment shall respond to changing conditions and parameters defined in the Contract Documents.
  - b. Illumination Levels: Average light levels in the tested space at the work plane elevation shall be in the range of plus or minus 10% of the specified light level range for the space.
  - c. Lighting Power Density: Average instantaneous lighting power density shall be within plus or minus ten percent of that indicated in the Construction Documents.
  - d. Power factors on lighting circuits shall be greater or equal to 0.95, or as required by lighting fixture specifications.
  - e. Electrical system total harmonic distortion shall be smaller than 20%.
  - f. Electrical equipment AIC ratings shall be as indicated in construction drawings.
  - g. Feeders % voltage drop. Flag feeders with voltage drop greater than 3%.

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6. Sampling Strategy for Identical Units:
  - a. Lighting Controls: Test all automatic interior lighting controls.
  - b. Illumination Levels: Test all spaces, zones and rooms to verify as proper light levels.
- C. HVAC Electrical Component Testing
  1. Document HVAC Division 23 electrical components using the startup procedure submitted by CONTRACTOR and accepted by the CxSP.
  2. Complete and submit Start-up, Pre-functional, and Functional Checklists.
  3. Verify the following information prior to HVAC system equipment startup.
    - a. Voltage.
    - b. Phase.
    - c. Motor Size.
    - d. Lock Rotor Amperage.
    - e. Full Load Amperage.
    - g. Minimum and Maximum Circuit Ampacity.
    - h. Feeder protection or branch circuit protection, breaker or fuse size as applicable.
  4. Coordinate and check corresponding unit electrical protection.

### 3.04 ADJUSTING

- A. Incorrect installations, including improper adjustments may result in additional work being required for Cx acceptance.
  1. Perform work required to correct installations not meeting contract requirements at no additional cost to the OWNER.
- B. Corrective work shall be completed in a timely manner to permit completion of the Cx process.
  1. Refer to the Cx Plan for retesting requirements necessary to achieve required system performance.
  2. If the systems' Cx deadline, as defined in the Cx Plan, goes beyond the scheduled completion of commissioning without resolution of the problem, the OWNER reserves the right to obtain supplementary services or equipment to resolve the problem.
    - a. The cost of additional and/or supplementary services inquired by OWNER as a result of CONTRACTOR's lack of performance, or inability to resolve identified issues will be solely the responsibility of the CONTRACTOR.

### 3.05 TRAINING

- A. Provide training and documentation as required in construction documents.

**END OF SECTION**

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**SECTION 26-0923 - LIGHTING CONTROL SYSTEMS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Low-voltage lighting control system.
- B. Related Requirements:
  - 1. Division 01 – General Requirements.
  - 2. Section 26 05 00 – Common Work Results for Electrical.
  - 3. Section 26 05 13 – Basic Electrical Materials and Methods.
  - 4. Section 26 05 19 – Low-Voltage Wires (600 Volt AC).
  - 5. Section 26 05 33 – Raceways, Boxes, Fittings, and Supports.
  - 6. Section 26 08 00 – Electrical Systems Commissioning.
  - 7. Section 26 24 16 – Panelboards and Signal Terminal Cabinets.
  - 8. Section 26 50 00 – Lighting.

**1.02 SUBMITTALS**

- A. Provide in accordance with Division 01.
- B. Submit a complete one-line diagram of the proposed system configuration for Architect/Engineer's review. The riser diagram shall identify but not be limited to wiring, equipment, components, interconnection with other systems, and location and type of raceways.
- C. Manufacturer's Data: Submit catalog cuts and description of each system component.
- D. Provide wiring diagrams and installation details for lighting control equipment.
- E. Provide a complete sequence of operation and system interface requirements with fire alarm, and other applicable systems as depicted in construction documents.
- F. Shop Drawings: Submit a complete set of detailed Shop Drawings for the entire lighting control system; the shop drawings shall include but not be limited to relay panels with designations and dimensions, day light sensor locations based on manufacturer's recommendations, and system components with manufacturer's part numbers.

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- G. Installation Instructions: Submit manufacturer's written installation instructions, wiring diagrams. Instructions shall include recommendations for handling of equipment and parts, and protection and storage requirements.
- H. Software flow diagram of and complete sequence of operation.
- I. Software licenses and electronic keys, and list of assigned passwords.
- J. Supplemental local or factory training schedule for post warranty support.
- K. A complete list of recommended spare parts with pricing for the OWNER's use in keeping the environmental control system downtime to a minimum.

### **1.03 QUALITY ASSURANCE**

- A. Components shall be listed and labeled by Underwriter's Laboratories (UL), or another Nationally Recognized Testing Laboratory (NRTL).
- B. Lighting control system and peripheral devices with IP addresses shall be UL listed in compliance with UL-2900 – Cyber Security Network Connected Systems.
- C. Lighting Control Systems shall comply with the state of California Building and Electrical Codes, and Title 24 energy requirements in effect at time of submittal for building permit.
- D. Conduct a coordination meeting with the lighting control contractor, electrical contractor, EOR, Manufacturer Representative, Commissioning Agent, and the OAR to validate the location of lighting control system components, including daylight, vacancy, motion sensors. Sensors shall be located based on manufacturer's recommendations.
- E. Systems components shall be Title 24 compliant and listed as California Energy Commission approved products.

### **1.04 WARRANTY**

- A. Manufacturer shall provide a three-year material warranty.
- B. Installer shall provide a two-year installation warranty.

### **1.05 TRAINING**

- A. Provide a competent instructor who is factory trained and has comprehensive knowledge of system components and operations to provide full instructions to designated personnel in the system operation, maintenance, and programming. Training shall be specifically oriented to installed equipment and systems.
- B. Training shall include system overview, time schedules, override commands, emergency operation, and programming and report generation for school based non-technical personnel.

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- C. Provide an eight hours OWNER's personnel and Maintenance and Operations technical employees training session; this training session shall cover and provide the following:
  - 1. As-built drawings of System layouts and point to point connection diagrams.
  - 2. System components cut sheets.
  - 3. Operations and maintenance data.
  - 4. Programmer and maintenance training: database entry; trend logs application programs, diagnostic routines, reporting, failure recovery and calibration, and expose the trainees to system's features, components, system architecture, operations, programming, report generation, communications, reading and interpreting alarms, and any other pertinent information required for the operations and maintenance of the system.
  - 5. Training sessions shall accommodate a minimum of 20 persons and be facilitated at CONTRACTOR's training facility, which should be no more than 50 miles from the Project Site.
  - 6. Obtain OWNER's approval for training locations exceeding 50 miles. In such cases, the CONTRACTOR shall be responsible for transportation expenses.
  - 7. CONTRACTOR shall provide training computers for all attendees. Computers shall be ready for live training sessions.
  - 8. Instructor(s) shall give the trainees the opportunity to practice on simulated and actual (installed) systems.
- D. The training session shall have an itemized agenda covering all aspects of the training to be covered in the sessions. CONTRACTOR shall obtain agendas approval from OWNER and Commissioning Agent.

### 1.06 SYSTEM REQUIREMENTS

- A. The lighting controls shall be a centralized system furnished with digital room controllers, capable of working as a network system that communicates via common data line (s).
- B. The system shall be furnished with transformers, control electronics, hardware, resident software and complete programming, occupancy sensors, constant light controllers, exterior light sensors, photocells, digital and analog switches, dimmer switches, conduit and wiring for a complete and functional installation.
  - 1. Software shall be resident within the lighting control system.
  - 2. System shall provide local access to programming functions at the master Lighting Control Panel (LCP) and remote access to programming functions via computers or other intelligent communication devices running an industry standard internet browser.

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3. System software shall provide real time status of all components and ancillary devices.
  4. For on-site access, the lighting control system shall have a built-in touchscreen allowing authorized access to localized control and programming
- C. Areas controlled by a motion sensor; such as rooms with one luminaire and emergency fixtures designed to operate 24 hours a day, seven days a week shall be programmed accordingly.
- D. The system shall have a server built into the master LCP. The server shall effectively work/operate through HTML pages from any authorized workstation.
1. WEB front end shall be accessible over an OWNER provided Ethernet 10/100 Mbps to the local area network.
  2. Protocol shall be TCP/IP and allow either http (hypertext transfer protocol) or https (hypertext transfer protocol secured) connections.
- E. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital, non-server capable systems are not acceptable.
- F. Lighting control system shall be able to be monitored and take commands from a remote Personal Computer (PC); should the remote PC go off-line system programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an on-line PC or server for normal operation are not acceptable
- G. Devices shall be factory pre-addressed but be able to be field addressable also. Systems requiring field addressing only are not acceptable.
- H. Programs, schedules, time of day, etcetera, shall be held in non-volatile memory at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.
- I. System shall be capable of flashing lighting OFF/ON for any relay or lighting zone prior to the lights beings turned OFF. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled OFF sweep using local lighting zone override switches within the zone or occupied space. Occupant override time shall be pre-programmed not to exceed two hours, or current California Title 24 requirements.
- J. The system shall be capable of implementing ON, OFF, Raise (dimming), and Lower (dimming), and preset commands, group or zone by means of devices connected to programmable inputs in the lighting control system.
- K. Programming and scheduling shall be done at the master LCP and/or remotely via the Internet. Remote connections shall function in real time control and real time feedback.
- L. System may consist of centralized relay panels, room controllers, digital switches, analog switches, photocells, motion sensors, lumen control devices, dimmer

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switches, and various digital interfaces. All system components, including remote and centralized room controllers, digital switches, etc. shall operate and be integrated as a network.

1. Remote Room Controllers (RRC) shall control lighting fixtures in that area or space.
  2. The RRC shall provide power to ancillary and control devices, such as occupancy sensors, and take input from controlling devices, such as daylight and occupancy/vacancy sensors.
  3. RRC's shall be capable of taking inputs from OWNER specification line voltage type switches.
- M. RRC, switches, photocells and occupancy sensors, and ancillary devices and components shall be integrated per lighting control manufacturer's instructions.
- N. Location of devices and relay panels or relay controllers installed above ceilings shall be identified with a printed label attached to ceiling elements. Locate label directly below equipment location.

#### **1.07 LIGHTING CONTROL OVERVIEW-BY AREA CONTROLLED**

A. Rooms:

1. The rooms shall be controlled by a combination of vacancy sensors, daylight controllers and dimmers switches.
  - a. The vacancy sensor is to automatically switch lights OFF when the room is not occupied for 15 minutes.
  - b. Daylight controls shall automatically adjust light intensity according to the natural light level in the room to maintain a uniform level of lighting in the range of 30-50 foot-candles.
  - c. The daylight sensors shall be enabled and disabled by the vacancy sensors to ensure daylight-controlled lights never automatically turn ON when room is unoccupied. The lighting control system shall allow an authorized person to disable the daylight sensors and dimming controls.
  - d. Wall switches, and dimmers are to manually switch lights ON and OFF. Switches shall comply with the operational requirements of the current T24, and include location of device, accessibility and override capability.
  - e. Quiet time switch is to temporarily bypass the occupancy sensors for a pre-programmed period of one hour, or as indicated on drawings.

B. Corridors and Open Areas:

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1. Corridors and other common areas are to be controlled by a combination of programmable low voltage keyed switches and time schedules supplied by the networked lighting control system.
  - a. Low voltage keyed switches are operable 24 hours a day and are to manually switch lights ON and OFF.
  - b. The central timer is to automatically sweep lights OFF after hours and provide scheduling capability where and when occupancy sensors are not used.
  - c. Interior corridors require occupancy sensors.
- C. Custodial, Unsupervised and Equipment Rooms:
  1. Provide occupancy sensors with automatic on-off capability in addition to manual switches, and programming features indicated on plans. These sensors shall turn off the lights in the room via 15 minutes pre-set programmable interval after the room has been vacated.
- D. Exterior Security Lights:
  1. Program exterior wall packs and security lights to be controlled via exterior light sensors, and time switches as indicated on drawings.
    - a. Program lights to ON state when natural lighting is below 5 foot-candles
    - b. Program lights to OFF when natural light level is greater than 5 foot-candles.
- E. Exterior, Non-Security Lights:
  1. Exterior non-security lighting in parking lots, corridors and pathways, and decorative lights shall be controlled via exterior light sensor working in conjunction with programmable controlled time schedules via the lighting control system.
    - a. Program lights to ON state when natural lighting is below 5 foot-candles, and when scheduled time is set to ON.
    - b. Program lights to OFF state when natural light level is greater than 5 foot-candles, and when scheduled time is set to OFF.
- F. Restrooms:
  1. Student Restroom and Lactation Room Lighting and Exhaust Fans (Fans interlocked with lights):
    - a. Restroom lights shall be controlled from the lighting control panel via assigned relays.

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- b. Provide by-pass lock type, vandal resistance key operated switch adjacent to the door, and ceiling mounted occupancy sensors for on/off controls.
    - c. The sensor shall turn off the lights via a programmable pre-set 15 minutes interval, after the room has been vacated.
  - 2. Staff Restrooms Lights and Exhaust Fans (Fans interlocked with lights):
    - a. Restrooms lights and fan shall be controlled from the lighting control panel via assigned relays.
    - b. Provide ceiling mounted occupancy sensors, and by-pass toggle switches for system override adjacent to the door.
    - c. The sensor shall turn off the lights via a programmable pre-set 15 minutes interval, after the room has been vacated.
- G. Emergency Lighting:
  - 1. Provide emergency lighting controls circuitry to achieve override or bypass of manually operated switches, lighting control systems, dimmers and occupancy sensors during power failures.
  - 2. Each area of luminaries or groups of luminaries shall be equipped with and be controlled by a UL924 listed emergency lighting control unit to allow the detection of localized power failures.

## PART 2 - PRODUCTS

### 2.01 CENTRAL LIGHTING CONTROL PANELS

- A. Central Lighting Control Panels (CLCP) shall be located in electrical closets.
- B. Panels shall be surface or flush mounted type as indicated on Drawings, with a hinged door assembly. Doors shall be furnished with flush type locks, spring latching, Corbin locks for metal doors, keyed to Corbin No. 60 keys. Panels shall include the following components or features:
  - 1. Shall be preprogrammed and preassembled with control equipment and relays as indicated on the lighting plans.
  - 2. Shall be equipped with suitable dividers separating Class 1 and Class 2 compartments, 120V and 277V compartments as well as "normal and emergency" compartments.
  - 3. Lighting control relays as indicated on Drawings. Provide 10 percent spare relays for centralized relay panels up to the maximum capacity of panel.

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4. Shall be equipped with a neatly typewritten schedule with number and name of rooms or areas served by the relay circuits. Room numbers and names used shall be determined at the Project site and may not be those indicated on Drawings. Schedule shall indicate panel designation and voltage and shall be mounted in a frame under transparent plastic 1/32-inch-thick on inside of panel cabinet.
5. Each panel shall be rated for 120 or 277 VAC.
6. Shall be preassembled, preprogrammed and include relays capable of switching 20 amps lighting loads for 120 or 277 VAC.
7. Central lighting control panels, remote lighting control panels, relays, low voltage switches, interior light sensors, exterior light sensors, and associated control electronics shall be furnished by Lighting Control and Design (LC & D), Douglas Lighting Controls, or equal.
8. Approved products: Douglas Dialog Series, LC & D #GR-2400 series, or equal.

## **2.02 REMOTE ROOM CONTROLLERS**

- A. Remote Room Controllers (RRC) shall be mounted in the ceiling space as indicated on plans.
  1. Each RRC shall be connected to the network lighting control system using manufacturer's recommended wiring method and configuration.
  2. Provide a printed label "RLCP" to the T-bar grid below the RRC".
  3. Approved products: LC&D GR-2404 Series or Douglas WRC-4244.
- B. Each RRC shall contain the following hardware features:
  1. Digital dataline switch inputs.
  2. 12 VDC and 24 VDC inputs for occupancy sensors requiring DC voltage for analog occupancy sensors, or Digital dataline type inputs for occupancy and light sensors.
- C. Switches shall be capable of switching individual relays, local groups of relays within the panel or global groups of relays system wide. Each switch shall be configured to be ON, OFF, RAISE, LOWER, or Toggle.
- D. The RRC shall digital dataline occupancy sensors. The sensors shall be configured for OFF only or ON/OFF switching scenarios.
- E. Photo sensor shall be linked with occupancy sensing so that when light levels are high enough, the occupancy/vacancy sensor will not switch the photo-controlled relays ON.

## **2.03 RELAYS**

- A. Relays shall be warranted for a minimum of three-years.
- B. Relays shall be individually added or replaced. Lighting control systems incapable of replacing individual relays are not acceptable.
- C. Each lighting control relay shall be capable of controlling LED sources.
- D. Approved Products:
  - 1. Single Pole: Douglas WR-6161, LC&D SL-277-NC, or equal.
  - 2. Double Pole: Douglas WR-6172, LC&D SL-480-NC, or equal.

## **2.04 LOW VOLTAGE SWITCHES**

- A. Low voltage switches shall be wired in compliance with manufactures requirements. Digital switches shall be part of the lighting control system network.
  - 1. Provide stainless steel switch plates, unless noted otherwise in construction documents.
  - 2. Approved Products: LC&D Chelsea series, Douglas WSW-3500 series, or OWNER approved equal.
- B. Physical removal of any single switch shall have no effect on the communication between relay panels in the rest of the lighting control network. Lighting control systems requiring the continuous connection of all low voltage switches are not acceptable.
- C. Keyed switches shall be digital.
  - 1. Approved products: Douglas WSK-35XX Series, LC&D KS Series, or equal.
  - 2. Provide stainless steel switch plates, unless noted otherwise in construction documents.
- D. High abuse areas (common areas, Assembly, class Labs, etcetera) shall be controlled using a vandal resistant, touch sensitive high abuse switch and available with up to three buttons in a single gang. Multi gang versions shall also be available.
  - 1. Touch pads shall be stainless steel and capable of handling both high abuse and power wash cleaning crews' activities.
  - 2. Switches shall be digital or analog as indicted on plans.
  - 3. High abuse switch touch buttons shall control a single relay or group(s) of relays of the lighting control system.

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- 4. Touch buttons shall be controllable via programmed commands to enable or disable, ON, OFF, Toggle or Maintain operation functions. Programming shall be done locally or remotely.
- 5. Touch pad(s) shall be identified as to function by an engraved label.
- E. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cm spark) without any interruption or failure in operation.

### **2.05 INTERIOR DAYLIGHT SENSORS**

- A. Interior daylight sensors shall cause light fixtures to brighten or dim to maintain pre-determined and uniform light levels.
- B. The sensors shall permit any relay to switch at a unique light level and shall attempt to maintain a constant light level by switching individual relays ON or OFF as the ambient light level changes.
- C. Controllers offering single set point controls are not acceptable.
- D. Each interior daylight sensor shall continuously monitor the true light level and shall broadcast this level to lighting control network. Controllers requiring readings at the sensor head itself are not acceptable.
- E. Each interior daylight sensor shall be fully adjustable via the lighting control software. Controllers requiring adjustments at the sensor head are not acceptable.
- F. Provide daylight sensors in all rooms with windows. Refer to lighting plans to determine which switch legs are controlled by the daylight controller.
- G. Approved Products: LC&D iPC Series, Douglas WPS-3711, Douglas WPP-INT, or equal.

### **2.06 EXTERIOR LIGHT SENSORS**

- A. One exterior light sensor shall permit different relays to switch at different light levels. Sensors offering less than 14 remotely settable trip points are not acceptable.
- B. Exterior light sensor shall continuously monitor light levels and shall broadcast this level over the lighting control network. Exterior light sensor shall be fully adjustable via the networked lighting control system.
- C. Sensors and controllers requiring adjustments at the sensor head are not acceptable.
- D. Sensors shall be UL or NRTL listed for exterior application.
- E. Approved products: Douglas WPS-3741B, LC&D PCO, or equal.

### **2.07 DIMMING CONTROLLER**

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- A. Remote relay panels shall be capable of outputting 0V – 10V dimming signal for each relay provided in the remote room controller. LED Dimming drivers shall be controlled by industry standard 0V-10V control input.
- B. LED Drivers using proprietary control protocols shall not be acceptable.
- C. To maximize daylight harvesting and minimize disruption to occupants, each dimming output shall provide adjustment for baseline, start point, mid point, end point, trim fade up rate, fade down rate, time delay and enable/disable masking.
- D. Photocells settings must be remotely accessible.
- E. Systems that provide ON, OFF with Time Delay only and systems that do not provide remote accessibility are not acceptable.
- F. Mount photocells in locations indicated on plans and according to manufacturer's recommendations for daylight system type, open or closed loop. Trip points shall be able to be programmed and altered remotely via programming functions at the master Lighting Control Panel (LCP) and remote access to programming functions via computers or other intelligent communication devices.
- G. Photocells requiring manual trip point adjustment, or systems that provide local adjustment only are not acceptable.
- H. Photocells used for interior lighting control shall have multiple settings such as start-point, mid-point, off-point, fade-up rate, fade-down etc.
- I. Approved Products: Douglas WPS-3711, Douglas WPP-INT, LC&D iPC series, or equal.

### 2.08 OCCUPANCY SENSORS

- A. Occupancy Sensors:
  - 1. Ceiling-Mounted Dual Technology Sensors:
    - a. Sensors shall be dual technology infrared-ultrasonic capable of detecting presence in floor area to be controlled, by detecting Doppler shifts in transmitted ultrasound and infrared technology.
      - 1. ADI-Voice technology may be used in addition to the required infrared-ultrasonic features.
    - b. Detection shall be maintained when a person moves only within a maximum distance of 12 inches, in either a horizontal or vertical manner, at approximate speed of 12 inches per second. Lights shall not go off when a person is reading or writing while seated at a desk.
    - c. Each sensor shall be furnished with a convenient shunt provision, which will enable a person to by-pass sensor in event of failure.

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- d. Sensitivity shall not change more than ten percent in temperature range of 0 degrees F. to 120 degrees F., and in humidity range of ten percent to 80 percent. Sensitivity adjustment shall be provided for each technology.
- e. Time delay range shall be adjustable from 15 seconds to 15 minutes.
- f. Sensors power supply shall be provided by power pack, consisting of a transformer and contact closure relay in one package. Power output of transformer shall be capable of operating a minimum of two sensors.
- g. Approved products: Watt Stopper No. DT-200, similar as manufactured by Leviton, Sensor Switch, Unenco, or equal.

### B. Dual Technology Passive Infrared Wall Switch Sensors with Daylight Controls:

- a. Sensors shall be capable of detecting presence in floor area to be controlled, by detecting changes in infrared-ultrasonic energy. Small movements shall be detected such as when a person is writing while seated at a desk.
- b. Passive infrared sensor shall utilize a dual-element sensor and a multi-element fresnel lens.
- c. Sensor shall be furnished with a daylight filter which ensures that sensor is insensitive to short-wavelength infrared waves, such as those emitted by the sun.
- d. Sensors shall be furnished with convenient bypass provisions, which enable lighting to be turned on in case of failure.
- e. Time delay range shall be adjustable from 15 seconds to 15 minutes.
- f. Sensitivity adjustment shall range from 0 (off) to ten (maximum).
- g. Adjustments and mounting hardware shall be concealed under a removable cover to prevent tampering with adjustments and hardware.
- h. Each sensor shall cover up to 800 square feet, with a field-of-view of 180 degrees.
- i. Sensor shall be a completely self-contained control system.
- j. Power shall be provided via an internal transformer.
- k. Switching mechanism shall be a latching dry contact relay.
- l. Sensor shall be capable of switching from 30 to 1000 Watts, LED, incandescent or fluorescent light sources.

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- m. Sensor shall be furnished with a daylight feature, adjustable from ten to 400 foot-candles, that maintains lighting off when a desired foot-candle level is present.
- n. Sensors shall be dual voltage, 120 volt and 277 Volt.
- o. Approved products: Watt Stopper No. WI 200, I 300, similar as manufactured by Leviton Sensor Switch, Unenco, or equal.

### 2.09 UNIT INVERTERS

- A. Unit Inverters shall be rapid start type consisting of emergency power packs designed to be installed in channels of new lighting fixtures.
- C. Power pack construction shall be of durable polycarbonate housing.
- D. Units shall be furnished with test switches and pilot lights.
- E. Units shall automatically power designated lamp(s) for 90 minutes of emergency service upon failure of utility power.
- F. Upon return of utility power, battery shall automatically recharge.
- G. Batteries shall be field-replaceable, sealed, rechargeable, spill-proof, maintenance-free nickel cadmium.
- H. High efficiency inverter/charger design shall include low-voltage disconnect to prevent deep discharge of battery and dual voltage designed for connection to either 120 or 277 volts. Chargers shall recharge fully discharged batteries to provide 90 minutes operation within 24 hours. Power pack shall not operate if shut off manually.
- I. An unconditional five-year warranty is required.
- J. Approved products: Dual-Lite UFO-5 Series, Bodine, Iota I series, Beghelli Luce, or equal.

### 2.10 INTERFACE TO BUILDING MANAGEMENT SYSTEM

- A. When interface to the Building Management System is required, The lighting control system shall provide a BACnet/IP interface module that communicates with the BMS via a BACnet/IP network. (a collection of one or more IP sub networks (IP domains) that are assigned a single BACnet network number). Verify if interface to BMS is required.
- B. BACnet/IP interface module shall provide the capability for the BMS to:
  - 1. Communicate directly with each relay in the lighting control system network and each group used within the lighting control system.
  - 2. Monitor the status and status changes of each relay and each group.

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- C. Install wiring and confirm operation of the lighting control BACnet/IP interface module per the lighting control manufacturer's instructions. Installing, wiring, and interfacing of BMS components to the lighting control system.

### **PART 3 – EXECUTION**

#### **3.01 GENERAL**

- A. Lighting control system shall not be used for any other purpose other than its intended use and application.
- B. Provide required interconnections with other systems such as emergency power sources, fire alarm systems, and building management system as required or indicated on drawings.
- C. Installation shall meet or exceed standard practice of workmanship and quality.
- D. Drawings are diagrammatic in nature and indicate work to be provided, but do not provide means and methods, bends, transitions, or special fittings required to clear beams, girders or other work already in place. Investigate conditions where conduits are to be installed and furnished and install required fittings.

#### **3.02 INSTALLATION AND SET-UP**

- A. Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's drawings for location of line and low-voltage areas.
- B. Provide for digital type switches and make all connections according to lighting control manufacturer's requirements.
- C. Central Lighting Control Panels and Remote Room Controllers shall be connected via a data line (Douglas uses a non-polarized two No. 18 and LC&D uses Cat5 four twisted pair cable, with RJ45 end connectors). Connect entire lighting control system per manufacturer's requirements. Do not exceed manufacturer's total data line length requirement.
- D. Panels shall be located so that they are readily accessible and not exposed to physical damage.
- E. Panel locations shall be furnished with enough working space around panels to comply with the California Electrical Code.
- F. Panels shall be securely fastened to the mounting surface by at least four points.
- G. Unused openings in the cabinet shall be effectively closed.
- H. Cabinets shall be grounded in accordance with Article 250 of the California Electrical Code, and manufacturer's recommendations.

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- I. Lugs shall be suitable and listed for installation with the conductor being connected.
- J. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- K. Maintain the required bending radius of conductors inside cabinets.
- L. Clean cabinets of foreign material such as cement, plaster and paint.
- M. Distribute and arrange conductors neatly in the wiring gutters.
- N. Follow the manufacturer's torque values to tighten lugs.
- O. Before energizing the panelboard, the following steps shall be taken:
  - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
  - 2. Remove shipping blocks from component devices and the panel interior.
  - 3. Remove debris from panelboard interior.
- P. Follow manufacturers' instructions for installation.

### **3.03 OPERATING/SERVICE MANUALS**

- A. Service and Operation Manuals:
  - 1. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.
  - 2. Record drawings: Provide (3) printed and one electronic copy on flush media of as built documents in latest version of ACAD of the entire system; including, floor plans with equipment, and devices layouts and wiring, interconnections with other systems, conduit and cable runs, programmed configurations, sequence of operations, system labeling codes, system passwords, and other pertinent information.
  - 3. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.

### **3.04 PROTECTION**

- A. Protect all work, equipment and components of the lighting control system until Substantial Completion.

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**3.05 TESTING**

- A. Set-up, commissioning and testing of the lighting control system, and OWNER instruction shall include:
  - 1. Confirmation of system programming.
  - 2. Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors.
  - 3. Operation of system's features under normal and emergency operations.
  - 4. Before energizing check and demonstrate in the presence of the Project Inspector that cables and wire connections are free from short circuits, ground faults, and that there is continuity, and necessary insulation.
  - 5. Confirm system operations and functionality.
  - 6. Check system interface response to other systems such as fire alarm and emergency power system conditions.

**3.06 SPARE PARTS**

- A. Provide a minimum of five percent spare parts of each type of relay, sensors, switches, and peripheral devices.

**3.07 CLEANUP**

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

**END OF SECTION**

**SECTION 26-1000 - SERVICE ENTRANCE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Underground lighting and power service conduits from utility company service pole or other service point to Project service equipment.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 31 2313: Excavation, and Fill.
  - 3. Section 03 3000: Cast-In-Place Concrete.
- C. Reference Documents:
  - 1. Southern California Edison Transmission and Distribution, Electrical Service Requirements, October 27, 2023

**1.02 DESIGN REQUIREMENTS**

- A. Comply with requirements of utility company having jurisdiction. Where required and indicated on Drawings, install transformer vault, outdoor transformer enclosure, pad and slab box, manholes or other equipment pertaining to service.
- B. Consult utility company to determine exact location of serving point or service poles, quadrants on poles for service risers and work and material. Service installation shall be complete and ready for cable installation. Service cable will be provided by utility company and will be paid for by the Owner.
- C. Interrupting capacity of main circuit breaker and distribution circuit breakers shall be equal to or greater than available short-circuit current at point as obtained by utility company or computed by the Architect. Selective coordination between main and feeder circuit breakers is required.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Transformer Pads: Concrete transformer pads shall be provided as indicated on Drawings and shall meet requirements of serving electric utility company.
- B. Service Conduits: As described under Section 26 0533: Raceways, Boxes Fittings, and Supports. For utility portion of wiring and conduit runs, comply with utility company requirements.

**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Service conduits shall terminate at service poles or other service point, as indicated on Drawings and shall extend underground to main service terminating pull section as indicated. Bends in conduits shall be long radius type and sweeps shall have a radius of not less than 10 times conduit trade size. Underground conduits shall be encased in concrete three inches thick on all sides with multiple conduits spaced not less than 1-1/2 inches apart, or use utility company recommended spacing, whichever is greater. Provide support for conduits to prevent floating when encased.
- B. Service Cables:
  - 1. Overhead: Shall be connected to metering compartment of switchboards.
  - 2. Underground: Shall be in service terminating pull section as required and directed by utility company.

**3.02 CONDUITS CROSSING PUBLIC DEDICATED PROPERTY**

- A. Where service or other conduits cross a street, alley, highway, or other public dedicated property, provide necessary arrangements to open and close public property and pay costs in connection with required licenses, permits, fees and deposits. Conduits shall be installed in a manner required by authorities having jurisdiction.

**3.03 STRUCTURAL CONDITIONS**

- A. Where conduits are to pass through or interfere with structural members, or where notching, boring or cutting of structure is necessary, or where special openings are required through walls, floors, footings, or other building elements to accommodate electrical Work, such Work shall be performed as required by the approved Structural Drawings.
- B. Placement of conduits in concrete slabs and structural members shall comply with requirements of applicable section of CCR, Title 24, Public Works and shall be as required by utility service provider and, Architect.
- C. Where a concrete encasement for underground conduits abuts a foundation wall or underground structure which conduits enter, encasement shall be maintained in position in relation to structure as indicated on Drawings, or rest on a haunch integral with wall or structure, or shall extend down to footing projection, or shall be doweled into structure. Underground structures shall include manholes, pull boxes, vaults, and buildings.
- D. Cutting and patching of rough and finish Work shall be performed as required for installation of Work under this section. Patching shall be of same materials, workmanship and finish and shall accurately match surrounding Work.

**3.04 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**3.05 CLEANUP**

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

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END OF SECTION

## **SECTION 26-2413 - SWITCHBOARDS**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Section Includes: Main switchboard, including metering facilities required by the utility company.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 03 30 00: Cast-In-Place Concrete.
  - 3. Section 26 05 00: Common Work Results for Electrical.
  - 4. Section 26 05 13: Basic Electrical Materials and Methods.
  - 5. Section 26 05 26: Grounding and Bonding.
  - 6. Section 26 05 19: Low-Voltage Wires (600 Volt AC).
  - 7. Division 27: Communications.
  - 8. Division 28: Electronic Safety and Security.
- C. Related Industry Standards: The most current version of the following industry standards.
  - 1. ANSI/NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. California Electrical Code (CEC).
  - 3. IEEE C57.12.28 – Standard for Pad-Mounted equipment Enclosure Integrity.
  - 4. IEEE 551 - Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems.
  - 5. IEEE 1584 – Performing Arc-Flash Hazard Calculations.
  - 6. UL/ANSI 891 – Standard for Safety Switchboards.

#### **1.02 SUBMITTALS**

- A. Provide in accordance with Division 01.
- B. Shop Drawings:
  - 1. Include a front elevation indicating dimensions and locations of equipment on switchboard, make, kind and size or capacity of equipment and bussing, location of

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each service conduit entering switchboard, barriers, nameplate inscriptions, finish, total weight and size of switchboard and locations and sizes of anchor bolts.

- C. Fault Current, Coordination and Arc-Flash Reports: the following reports shall be prepared using SKM Systems Analysis, ETAP Powering Success, EasyPower, or equal.
1. Provide a short-circuit and coordination report signed and stamp by a registered electrical engineer. Studies shall be in accordance with applicable IEEE guidelines. Submit two copies of each study for review prior to ordering and installing equipment.
  2. Provide a system coordination report for main and branch circuit protective devices including transformers secondary protective devices. Study shall be recorded on log paper. The circuit protective devices shall be set based on the coordination study. A final written record of protective device settings shall be submitted.
  3. Provide a complete arch-flash report based on installed equipment, and feeders' sizes and lengths. Prepare the report in accordance with code requirements and IEEE 1584 standard. The report shall indicate trip times for protective device(s) settings, arcing fault current values, and incident energy and flash boundaries. The arc-flash report shall indicate clothing requirements for each piece of equipment.
  4. Provide installation detail and seismic anchorage notes for switchboards.

## **PART 2 – PRODUCTS**

### **2.01 SWITCHBOARDS**

- A. General Description: Switchboards shall be product of W.A. Benjamin Electric, Cuttler Hammer, General Electric, Siemens, or equal, and shall conform to the following requirements:
1. Complete assembly, including steel framing and covers, bus system, and breaker mounting, shall satisfy applicable provisions of UL 891 and NEMA PB-2 and the California Electrical Code for low-voltage distribution switchboards. Switchboards shall be furnished with UL labels.
  2. Switchboards shall be floor standing, dead front, dead rear, line bussed, front operated and connected, circuit-breaker type, unless otherwise indicated and shall contain equipment indicated and specified. Switchboard shall be complete with pull, service, and distribution sections as required.
  3. Required equipment shall be enclosed in fully interchangeable die formed steel sectional cabinets with top and bottom plates and required braces and gussets so that cabinets will be absolutely rigid, plumb and uniform in size. Each cabinet shall be a separate and independent unit with assembly holes die-stamped or jig drilled; openings for interconnections shall be so placed that cabinet can be located in any position in assembly without drilling or cutting holes on job. Deliver switchboard to Project site in completely assembled sections and provide required assembly bolts and blanking plates. Front plates and doors shall be of not less than 12 gage

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furniture steel, completely removable, secured to cabinet with machine screws, with cup washers uniformly and symmetrically spaced. Provide hinged wire gutter covers for distribution sections. Equipment shall meet NEMA and UL standards.

4. Main circuit breaker or main fusible switch shall be as follows:
  - a. Main circuit breakers shall be automatic, one-piece molded-case, trip-free, common trip, quick-make, quick-break, thermal-magnetic with solid state trips, bolted to bus with frame size and trip ratings as indicated on drawings. Voltage, amperage ratings and number of poles shall be as indicated on breakers. Main breaker shall provide a minimum short-circuit interrupting capacity as determined by utility company. Provide shunt-trip and integral ground fault devices, as indicated on drawings. Breakers shall be furnished with lockout provisions.
  - b. Main fusible switch 800 amps or larger ampacity shall be high pressure contact, stored energy, quick-make/quick-break operation, with current limiting fuses, as indicated on Drawings. Provide shunt-trip, and integral ground fault devices, as indicated on Drawings. Were required, switches shall be motor operated and be furnished with an electrical trip mechanism piloted by output of ground fault sensing circuitry. Switch shall be furnished with lockout provisions.
5. Feeder circuit breakers shall be automatic, one-piece molded-case, trip-free, common trip, quick-make, quick-break, thermal-magnetic or solid-state type bolted to bus, with handles clearly indicating tripped position. Breakers shall be furnished with a single handle with no tie-bar. Voltage, amperage, and number of poles shall be as indicated on Drawings. Breaker ratings shall be on handle or label. Breakers shall be furnished with lockout provisions approved by the State of California for padlocking and shall provide a minimum symmetrical short-circuit interrupting rating, as indicated on Drawings. Series rated circuit breaker combinations are not acceptable.
6. Fusible feeder switches shall be quick-make, quick-break, voltage rating and number of poles as indicated on Drawings, with visible blades and dual horsepower ratings. Switch handles shall physically indicate on and off positions. Switches shall be lockable only in off position and accept three industrial type heavy-duty padlocks. Switch covers and handles shall be interlocked to prevent opening in on position. Provide means to permit authorized personnel to release interlock for inspection purposes. Switches shall be equipped with Class R current limiting fuses or dual element fuse of size and capacity indicated on Drawings.
7. Utility metering provisions shall meet requirements of serving utility and shall be furnished with necessary fittings.
8. Provide switchboard silver-plated copper bus bars of same capacity as main breaker, or as indicated on Drawings, between current transformer and main section and distribution sections; also, full height of breaker space in distribution portions. Copper bus shall have current density of 1000A per square inch of cross section. Bus structure shall be free-fitted and shall have sufficient strength to withstand short-circuit as indicated on drawings. Connections shall be securely

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bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices. Bus bar bracing shall be designed to withstand maximum available short-circuit current. Connections for cables to circuit breakers, switches and motor control devices shall be heavy-duty mechanical pressure type terminal lugs. Provide service cable lugs as required by utility company. Cables and internal wiring shall be supported with suitable cleats.

9. Switchboard distribution sections shall be furnished with full height bussing. Unused spaces shall be provided with blank covers. Switchboards, as complete units, shall be given single short-circuit current ratings by manufacturer. Such ratings shall be established by actual tests by manufacturer, in accordance with UL specifications, on equipment constructed similarly to the furnished switchboard.
10. Provide a large nameplate identifying switchboard, indicating service voltage, originating power source, function and current rating. Nameplate shall be furnished with 3/16-inch engraved black letters on white background. Name plate shall be mechanically fastened to switchboard.
11. Provide labels for circuit breakers, disconnect switches, and or other disconnecting means in switchboards. Labels shall be a P-Touch type or equal, with a minimum width of 3/8 inch with black letters on white background. Label shall indicate name of load served, name or room number and if in different building, name of building. If equipment is installed in same room as source, label should indicate source name and "in this room".
12. Paint cabinets, framework and plates inside and out with one coat of rust-resistant metal primer and one coat of gray enamel, baked on, or lacquer sprayed on.
13. Manufacture boards according to reviewed Shop Drawings. Switchboard shall meet requirements of legally constituted authorities having jurisdiction, and respective serving utility.
14. Switchboards installed outdoors shall be weatherproof NEMA Type 3R enclosure. Enclosure construction shall be formed of code gage galvanized steel with ANSI No. 61 gray enamel finish. Heavy-duty, three-point latching, vault type door handles with padlocking provisions shall be furnished on doors. Padlocks shall be furnished keyed to Corbin No. 60 keys. Switchboards installed outdoors shall be specifically required to maintain service during extreme outdoor ambient temperatures of a minimum of 150 degrees Fahrenheit in NEMA Type 3R enclosures.
15. For grounded wye electrical service switchboards rated more than 150 volts, to ground and 1,000 amperes or more, provide ground fault protection for main protective device. Ground fault protection shall be UL listed, with ground sensor encircling phase conductors and neutral conductors integral with the main protective device. Provide testing of ground fault protection system by an independent recognized testing laboratory. Testing lab shall provide necessary testing equipment at the Project site and perform a certified test on ground protection system in presence of the Project Inspector. The ground fault setting shall be selected to coordinate with downstream circuit protective devices. Verify

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that the system neutral is grounded at the service entrance switchboard only, except neutrals of step-down distribution transformers. For branch circuit protective devices, rated 800 amps or more, provide ground fault protection where shown on the drawings, or as described above, for main protective device. Coordinate settings with main protective device ground fault protection.

16. In main and distribution switchboards provide a multifunctional digital meter with true RMS measured Amperes (each phase and neutral) Volts (line-to-line and line-to-neutral), Power Factor, Frequency, VA, VAR, Watts, KWH, KVARH, KVAH, voltage/current unbalance, and demand metering: W, VAR, Amperes, VA. Meter to have a front mounted RS232 port to allow programming and meter values via laptop computer and supplied software. The meter shall be GE Multiline PQM with BACnet translator capabilities; equal or better meters will be acceptable with District's approval only. Contractor shall supply the metering software and electronic key to owner.
17. Connections to bussing shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. Switchboards shall be located so that they are readily accessible and not exposed to physical damage.
- D. Switchboard locations shall provide sufficient working space around the switchboard to comply with the California Electrical Code.
- E. Switchboards shall be securely fastened to the mounting surface.
- F. Switchboard cabinets shall be grounded as specified in Article 250 of the California Electrical Code.
- G. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.
- H. Lugs shall be suitable and as required for installation with the conductor being connected.
- I. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- J. Maintain the required bending radius of conductors inside the cabinet.
- K. Distribute and arrange conductors neatly in the wiring gutters.
- L. Tightening the wire lugs or conductor connections shall be performed in the presence of the Project Inspector. Torque values shall be those recommended by manufacturer.

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- M. Remove shipping blocks from component devices.
- N. Manually exercise circuit breakers to verify they operate freely.
- O. Remove debris from switchboard interior.
- P. Follow manufacturer's instructions for installation.
- Q. Furnish one spare fuse for each fusible switch installed. Spare fuses shall be of the same type and rated as those installed.
- R. Do not install in highly corrosive environments such as pool equipment, boiler, chemical and corrosive materials storage rooms, and similar areas. When equipment is installed in such areas, it shall be labeled and listed for the application.
- S. Switchboard equipment and system components shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of bolted electrical connections, and perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one minute in accordance with requirements stated in NETA-ATS 2007 table 100.1. Test shall be performed in the following manner:
  - 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of bussing, circuit breakers and/or fused switches. The fused switches shall be equipped with fuses or temporary jumpers in place of fuses. Breaker and fused switches shall be tested in the closed position. No wiring shall be connected to the line or load side of the switchgear during testing.
    - a. Provide calibration program records to assure the testing instruments to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
    - b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
    - c. Test reports shall include the following:
      - 1) Identification of the testing organization.
      - 2) Equipment identification.
      - 3) Ambient conditions.
      - 4) Identification of the testing technician.
      - 5) Summary of project.
      - 6) Description of equipment being tested.

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- 7) Description of tests.
  - 8) Test results.
  - 9) Analysis, interpretation and recommendations.
1. Perform tests in the presence of the Project Inspector.
  2. During testing, provisions shall be made to prevent damage to solid state components, or electronic equipment such as TVSS equipment that may be tied onto switchboard bussing.
  3. Test results shall meet manufacturer's recommendations or NETA ATS- 2007 recommendations, whichever is more stringent.

### **3.02 PADS AND ANCHORING**

- A. Where free-standing equipment is installed at exterior locations or in locations below grade, concrete pads shall be provided as specified in Section 03 3000: Cast-In-Place Concrete.
- B. Where a utility meter is installed in a switchboard, concrete pad shall extend three feet from face of switchboard door or board, whichever is greater. Concrete pad installation shall comply with electric utility company requirements.
- C. Anchor bolts for freestanding equipment shall meet CBC Seismic design requirements, and manufacturer's installation recommendations. The more stringent requirements will be enforced.
- D. Project Record Documents: Provide project record drawings of switchboards as installed, indicating main and branch circuit ratings, circuit numbers and part numbers.
- E. For ground fault relays and sensors, the following information shall be provided:
  1. Certified Calibration and Acceptance Test.
  2. Installation Instructions.
  3. Operating Instructions.
  4. Maintenance Instructions.
  5. Replacement Parts List.
  6. Final Test Report.
- F. Test information shall be submitted to the Architect. Nameplates may be fabricated of engraved laminated plastic or etched metal and shall be permanently attached with escutcheon pins or screws.

### **3.03 PROTECTION**

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- A. Protect the Work of this section until Substantial Completion.

**3.04 CLEANUP**

- A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

**END OF SECTION**

## SECTION 26-2416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Lighting and power distribution facilities, including panelboards.
- B. Related Requirements:
  - 1. Division 01 - General Requirements.
  - 2. Section 26 05 00: Common Work Results for Electrical.
  - 3. Section 26 05 13: Basic Electrical Materials and Methods.
  - 4. Section 26 26 00: Power Distribution Units.
  - 5. Section 26 50 00: Lighting.
  - 6. Division 27: Communications.
  - 7. Division 28: Electronic Safety and Security.

#### 1.02 SUBMITTALS

- A. Provide in accordance with Division 01.
- B. Shop Drawings: Include a front elevation indicating cabinet dimensions, make, location and capacity of equipment, size of gutters, type of mounting, finish, and catalog number of locks. General layout of internal devices, wiring drawings with wire numbers and device connections, vendor cut sheets of devices in enclosure and bill of materials listing description, manufacturer, part number, and quantity of items shall be included.
- C. Installation Instructions: Submit manufacturer's written installation instructions.

#### 1.03 DESIGN REQUIREMENTS

- A. Panelboards:
  - 1. Panelboards shall be wall-mounted, enclosed safety type with 120/240 volt, three-wire solid neutral 277/480 volt, four-wire or 120/208 volt, four-wire solid neutral mains as indicated on Drawings or specified. First panelboard of each building shall be provided with main or sub-feeder circuit breakers where so indicated.
  - 2. Single pole branches shall be molded case, thermal magnetic circuit breakers with inverse time delay, trip free, quick-make, quick-break mechanism and silver alloy contacts. Circuit breakers shall be fully rated, with ampere rating marked on handle and shall indicate on/off and tripped positions. Ground fault

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interrupters shall be incorporated into circuit breakers where indicated. They shall be listed by UL, or other NRTL as ground fault devices. Provide appropriate lug kit of sufficient size to accommodate the feeders.

3. Two- and three-pole branches shall be enclosed and shall be thermal magnetic circuit breakers with inverse time delay, tamper-proof, ambient compensated, single handle, internal common trip, and quick-make, quick-break mechanism with silver alloy contacts. Circuit breakers shall be fully rated or as otherwise indicated on the Drawings.
  4. Main and subfeeder circuit breakers shall be enclosed, thermal magnetic type with inverse time delay, single handle common trip, quick-make, quick-break mechanism, corrosion-resistant bearings and silver alloy contacts. Ampere frame size and trip rating shall be as indicated on Drawings. Breakers over 225 amperes shall be furnished with interchangeable trip units. Handles of main and subfeeder circuit breakers shall be provided cabinet door. Voltage rating shall be as indicated on Drawings.
  5. Circuit breakers shall be fully rated and of one-piece, bolt-on type and shall meet short-circuit interrupting capacity requirements indicated on Drawings. Series rated circuit breaker combinations are not acceptable.
  6. Internal connections shall be fabricated with plated copper bus bars and the busses shall extend for full length of space available for branch circuit breakers. Feeder cable connectors shall be installed at point of feeder entrance. Terminals shall be furnished with copper conductors. Panelboards fed by conductors having over-current protection greater than 200 amperes shall be protected on supply side by over-current devices having a rating not greater than that of panelboards. Copper bussing shall be fully rated. Heat rated bussing is not acceptable.
  7. Except where otherwise indicated, circuit breakers shall be in two vertical rows connected to bus bars in a distributed phase arrangement. Two-pole branches shall be balanced on busses. Single pole branches shall be numbered adjacent to its circuit breaker, with odd numbers on left and even numbers on right.
  8. Specified circuit breaker spaces shall be furnished with hardware required for future installation of circuit breakers.
  9. Provide locking devices for individual circuit breakers. Padlocking devices shall be secured to circuit breakers and by panel dead front plates.
- B. Surge Suppressors: Where indicated on Drawings, provide transient voltage surge suppressors as an integral part of panelboards. Panelboards shall be complete with 200 percent rated copper neutral bus, ground bus and isolated ground bus in addition to requirements of this section. Surge suppressors shall be as follows:
1. Surge Capacity:
    - a. Line-to-neutral for wye systems: 80 KA.

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- b. Line-to-ground: 80 KA.
  - c. Neutral-to-ground: 80 KA, three-phase wye.
  - d. Line-to-neutral plus line-to-ground: 160 KA.
- 2. UL 1449 2<sup>nd</sup> Edition Suppressed Voltage Rating for 208/120 Wye System:
  - a. Line-to-neutral: 400 volts.
  - b. Line-to-ground: 400 volts.
  - c. Neutral-to-ground: 400 volts.
  - d. Maximum continuous over-voltage: 150 volts.
- 3. EMI/RFI High-Frequency Noise Power Filter (Characteristics):
  - a. 100 KHz at 44 dB.
  - b. 100 MHz at 44 dB.
  - c. 10 MHz at 44 dB.
  - d. 100 MHz at 44 dB.
- 4. Metal Oxide Varistor (MOV) shall be thermally protected for low current faults and shall be fused with surge-rated fuses. The surge-rated surge current passes and clears the circuit safely if the surge capacity is exceeded. Enhanced diagnostics shall continuously monitor the unit's status and shall include LEDs to signal a reduction in surge capacity or the loss of a suppression circuit. An audible alarm, with test and silence features, shall be furnished in diagnostic package.
- 5. Each phase or the entire unit shall be replaceable and have bolted-on, tin-plated copper connections. Unit to have UL witnessed fault current rating of 65,000 symmetrical amperes.
- 6. Surge suppression units shall comply with the following:
  - a. UL certified.
  - b. UL 1283.
  - c. UL 1449.
  - d. IEEE C 62.45.
  - e. IEEE C 62.41.
  - f. Nationally Recognized Testing Laboratory (NRTL) or equal.

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C. Panelboard Cabinets:

1. Panelboard cabinets shall be code gage galvanized steel or blue steel; fronts, doors, and trims shall be code gage furniture steel. Cabinets shall be furnished with at least six-inch high gutters at top and bottom where feeder cable size exceeds four gage or where feeder cable passes through cabinet vertically. Cabinets shall be furnished with top and bottom gutters sized as required by inspection department having jurisdiction, but never less than six inches where more than one feeder enters top or bottom of cabinets. Side gutters shall not be less than four inches wide. Width of cabinets shall be 20 inches, unless otherwise indicated on Drawings.
2. Doors shall be cut true, shall accurately fit opening and finish smooth across joints. Rabbets shall be inside. Hinges shall be entirely concealed except for barrels and pins. Hinge flanges shall be welded to door and trim. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors, keyed to Corbin No. 60 keys.
3. Where contactors, time switches, and control devices are specified or indicated to be installed within panelboard cabinets, a separate compartment and door shall be provided at top of cabinet for such devices. Door shall be sized as required to permit removal of contactor and other devices intact. Gutters shall be provided at sides and top of compartment. Doors shall be equipped with flush type, spring-latching, Corbin locks for metal doors keyed to Corbin No. 60 keys.
4. Provide and install panelboard manufacturer's permanent circuit number kit option.
5. Panelboards with control devices in compartment shall arrive at the Project site completely assembled with control devices installed and wired.
6. Outdoor cabinets shall be NEMA Type 3R. Construction shall be formed from code gage galvanized steel with ANSI No. 61 gray enamel finish. Provide heavy-duty, three point latching, vault type door handles with padlocking provisions. Provide stainless steel or galvanized butt hinges on doors. Padlocks shall be furnished, keyed to Corbin No. 60 keys.
7. Self-tapping screws and bolts not permitted.

D. Panelboard Schedule: Provide a neatly typewritten schedule with number or name of room or area, or load served by each panelboard circuit. Room numbers or names shall be determined at the Project site and shall not necessarily be those indicated on the Drawings. Schedule shall also indicate panel designation, voltage and phase, building and distribution panel or switchboard from which it is fed. Schedule shall be installed in a frame under transparent plastic 1/32 inch thick on inside of each panelboard cabinet door.

E. Panelboard nameplate: Provide a nameplate identifying panelboard. Plates shall be black and white plastic nameplate stock, with character cut through black exposing

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white and shall bare designation of service. Name plate shall be mechanically fastened to switchboard.

- F. Provide additional labeling on dead-front of panelboard. Label shall be a P-Touch or equal with a minimum width of 3/8 inch with black letters on white background. Label shall re-identify panelboard and also identify name and location of power source feeding this panel. Location information shall include building name if located in different building and name or room location. If power source is installed in same room, label should indicate source name and "In this Room"
- G. Panelboard Standards: Panelboards shall be UL, or other NRTL listed and labeled. Panelboards shall meet latest revisions of following standards:
  - 1. California Electric Code, Article 384.
  - 2. UL 67, Panelboards.
  - 3. UL 50, Cabinets and Boxes.
  - 4. UL 943, GFCI.
  - 5. UL 489, Molded Case Circuit Breakers.
  - 6. NEMA PB1.
  - 7. Federal Specifications W-P- 115C and WC-375B.
- H. Signal Terminal Cabinets:
  - 1. Signal terminal cabinets shall conform to the Specifications for panelboard cabinets, except as modified herein.
  - 2. Terminal cabinets shall be flush type, with two-inch trim or surface mounted type, as indicated on Drawings. Terminal cabinets shall be furnished with sections and barriers to separate each system. Sections over 24 inches in width shall be provided with double doors and locks. Terminal cabinets, or sections of terminals housing separate systems, shall measure 12 inches long by 18 inches high by 5 3/4-inch deep, unless otherwise indicated on Drawings. Trims for sectional cabinets shall be of one-piece construction.
  - 3. Terminal cabinets shall be furnished with 3/4 inch thick plywood. Plywood shall be fastened in place with machine screws or factory installed mounting screws.
  - 4. Flush-mounted terminal cabinets shall be finished as specified for flush-mounted panelboard cabinets. Surface and semi-flush mounted terminal cabinets shall be finished as specified for surface-mounted panelboard cabinets.

## PART 2 - PRODUCTS

### Panelboards - 262416

**2.01 MANUFACTURERS**

- A. Panelboards shall be manufactured by Siemens, W.A. Benjamin, General Electric, Cutler Hammer, Square D or equal.

**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Panelboards shall be located so they are readily accessible and not exposed to physical damage.
- B. Panelboards installed outdoors shall be specifically listed for wet locations and shall be weatherproof in NEMA Type 3R cabinets.
- C. Panelboard locations shall provide sufficient working space around panels to comply with the California Electrical Code.
- D. Panelboards shall be securely fastened to structure and mounted on surface by at least four points.
- E. Unused openings in cabinets shall be effectively closed as required by the manufacturer.
- F. Cabinets shall be grounded as specified in Article 250 of the California Electrical Code.
- G. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure.
- H. Lugs shall be suitable and listed for installation with the conductor being connected.
- I. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- J. Maintain the required bending radius of conductors inside the cabinet.
- K. Clean the cabinet of foreign material such as cement, plaster, and paint.
- L. Distribute and arrange conductors neatly in the wiring gutters.
- M. Use the manufacturer's torque values to tighten lugs.
- N. Before energizing panelboards, the following steps shall be taken:
  - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been provided.
  - 2. Remove shipping blocks from component devices and panelboard interiors.

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- 3. Manually exercise circuit breakers to verify they operate freely.
- 4. Remove debris from panelboard interior.
- O. Follow manufacturer's instructions for installation.
- P. Do not install in highly corrosive environments, unless rated for the application.

**3.02 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**3.03 CLEANUP**

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

**END OF SECTION**

## **SECTION 26-2419 - MOTOR CONTROL CENTER AND MOTOR CONTROL DEVICES**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Section Includes: Disconnect switches and motor starters for motors or equipment and connections to the motors.
- B. Related Requirements:
  - 1. Division 01 – General Requirements.
  - 2. Division 23: Heating, Ventilating, and Air Conditioning “HVAC”.
  - 3. Section 26 05 00: Common Work Results for Electrical.
  - 4. Section 26 05 13: Basic Electric Materials and Methods.
  - 5. Section 26 05 26: Grounding and Bonding.
  - 6. Section 26 24 13: Switchboards.

#### **1.02 SUBMITTALS**

- A. Shop Drawings: Include a front elevation, indicating dimensions, make, location and capacity of equipment, type of wiring, size of gutters, type of mounting, size of anchoring bolts and finish. Installation shall be in compliance with CBC seismic design requirements.
- B. Product Data: Submit catalogs indicating make, ratings, dimensions, and catalog number for disconnect switches, motor starters, and control devices.

#### **1.03 DESIGN REQUIREMENTS**

- A. Motor overload protection of manual reset type, as part of a motor starter and set at not to exceed 125 percent of motor full load current rating, shall be provided for each motor exceeding 1/8 horsepower in size except where indicated otherwise and except for following: Motors of sufficient impedance to prevent overheating on failure to start (such as clock motors), and motors provided with an approved built-in manual reset type device, responsive to motor current and set at not to exceed 125 percent of the motor full load current rating, which will interrupt current to motor.
- B. Switchboard components shall be provided with nameplates. Plates shall be black and white plastic stock, with characters cut thorough black exposing white, and shall bear designation of service, feeders controlled, and fuse sizes.

### **PART 2 – PRODUCTS**

#### **2.01 EQUIPMENT**

#### **Motor Control Center And Motor Control Devices - 262419**

A. Motor Control Centers:

1. Motor control centers shall be of metal-clad, free floor-standing dead-front type, totally enclosed with one or more vertical sections. Arrangement and construction shall be as indicated on Drawings and as specified. Design, construction, and testing shall comply with requirements of latest CEC, UL publication UL-845, NEMA publication ICS 2.3 and applicable standards of ASA, AIEE, and NEMA. Equipment shall be completely fabricated, wired and tested at factory, and shall be shipped in sections ready for installation, complete with required assembly bolts and mounting channels. General construction shall consist of modular vertical sectioned cubicles, approximately 90 inches high and 20 inches wide. Sectional cubicles shall be bolted together to form required arrangement having the appearance of a single assembly. Cubicle sections shall be fabricated from a minimum of 12 gage P & O Mill prime sheet steel, shaped, reinforced, and welded to form a rigid structure. Sections shall contain required number of modular spaces for various starter units. Wiring gutters shall extend through cubicles with front accessible bolted filler plate covers. Connections shall be securely bolted together with corrosion-resistant plated carbon steel, of minimum grade five machine screws, secured with constant pressure type locking devices. Self-tapping screws will not be permitted.
2. Bus bars and connections shall be copper. Vertical buses shall be rated at not less than 300 amperes and shall be placed to allow starter units to be connected by pushing into place. Bus connections shall be free fitting and bolted, with silver plated connecting areas rated at 200 amperes per square inch. Bus work bracing and support shall withstand the short circuit stresses indicated on Drawings without damage to buses or structure. Connections shall be secured bolted together with corrosion-resistant plated carbon steel, of minimum grade five machine screws, secured with constant pressure type locking devices. Self-tapping screws will not be permitted.
3. Main horizontal and vertical buses shall be made of copper and entire length shall be electrolytically silver-plated. Copper ground lugs shall be provided in incoming line vertical sections. Horizontal tin-plated copper ground buses shall be provided in each section of the motor control center. Horizontal ground bus shall run continuously throughout control center, drilled and tapped every ten inches for  $\frac{1}{4}$  - 20 machine screws. RMS amperes symmetrical bus bracing shall be as indicated on Drawings. Vertical sections shall support horizontal and vertical buses, combination started units, covers and doors. Vertical sections shall be furnished with structural supporting members formed of a minimum of 13 gage hot-rolled steel. Reinforcement for structural parts shall be of ten gage steel to provide a strong, rigid assembly. Vertical sections shall be designed to accommodate bolts on units 20 inches wide and 20 inches deep, and shall be provided with 12 inches high horizontal wireway located at bottom of sections and a six-inch horizontal wireway at top of sections in addition to the vertical wireways for each section. Busing components shall be secured bolted together with corrosion-resistant plated carbon steel, of minimum grade five machine screws, secured with constant pressure type locking devices. Self-tapping screws will not be permitted.
4. Separate control cell compartments of sizes indicated on Drawings shall be provided for future interlocking relays and transducers.

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5. Starters shall be of the bolt-on combination magnetic type, as indicated on Drawings, each with a separate hinged door. Starters shall be provided with separate overloads in each phase.
    - a. Combination magnetic starters shall be circuit breaker magnetic across-the-line type, or as indicated on Drawings, and shall be furnished with suitable thermal overload elements for controlled motor. Breaker shall be bussed with copper bus bars. Covers shall be mechanically interlocked with circuit breakers to prevent opening when energized. Circuit breaker handles shall be capable of being padlocked in the off position with one to three padlocks.
    - b. Each motor starter shall be furnished with a red pilot light, HOA selector switch or pushbutton station, and a control circuit transformer, unless otherwise indicated on Drawings. Control circuit transformer shall be fused.
  6. Units shall be provided with unit doors, unit support pans, unit saddles, and unit disconnect operators. Units shall be designed and constructed so that faults will be localized within compartment.
  7. Control devices and wiring of motor control centers shall be in accordance with functional wiring diagrams indicated on Drawings and requirements of controlled equipment.
  8. Motor control center wiring shall be NEMA Class 1, Type B.
  9. Motor control center shall be as manufactured by Cutler Hammer, W.A. Benjamin Electric, Square D, General Electric, or equal.
- B. Disconnect Switches:
1. Heavy duty type switches shall be 240 volt or 480 volt as required, totally enclosed, externally operated, with quick-make, quick-break operating mechanism, interlock cover, and provisions for locking cover in closed position and locking switch in on and off positions. Switches shall be single-throw, unless otherwise indicated or specified. Switches controlling direct current loads shall be DC rated.
  2. Switches shall be furnished with switch blades, which are fully visible in off position when switch door is open. Current carrying parts shall be plated to resist corrosion and promote cool operation. Switches shall be furnished with removable arch suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL, or other Nationally Recognized Testing Lab listed for 75 degrees C. copper wires.
  3. Switch enclosure shall be NEMA Type 1 for indoor locations and rain-tight, NEMA Type 3R, rainproof for outdoor locations. NEMA Type 3R enclosures shall be manufactured from galvanized steel with gray baked enamel and shall be furnished complete with rainproof bolt on hubs. Covers shall be attached with pin type hinges. Removable closing cap types are not permitted. In kitchen area, provide disconnect switchers in a NEMA type 4 stainless steel enclosure. Quick release latches shall be permitted only when furnished tamper-resistant to prevent breakage due to vandalism, and

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furnished with Corbin 66 locks keyed to Corbin 60 key. Switches shall be fusible or non-fusible as indicated on Drawings. Fusible switches shall accept cartridge fuses. Current rating of switches, number of poles, solid neutral facilities, and current rating of fuses shall be as indicated on Drawings. Switches shall have proper horsepower rating equal to or greater than horsepower of motor controlled. Only lower horsepower rating of dual rated switches will be permitted as a switch rating. Switches shall accept Class H, Class J and Class R fuses.

4. Padlocking device shall lock operating handle and cover with one padlock regardless of on or off position. Switches shall be heavy duty type, as manufactured by Square D, General Electric, Cutler Hammer or equal. Furnish a minimum of two padlocks and two keys with each switch. Padlocks shall be Corbin No. 66 keyed to Corbin No. 60 keys.
5. Switches shall be UL listed and shall comply with NEMA Standard KS-1.
6. Furnish one spare fuse for each fusible disconnect switch installed. Spare fuses shall be same type and rating as those installed.

**C. Motor Starters:**

1. Motor starters shall be AC magnetic across-line starters unless otherwise indicated on Drawings.
2. AC magnetic across-the-line starters shall be furnished with manual reset thermal overload protective devices including heating elements. Starters shall be furnished in a NEMA Type 1, NEMA Type 3R or other type of enclosure as indicated on Drawings. Starters shall be furnished with HOA selector switches or push-buttons, as indicated on Drawings. NEMA size, voltage rating, number of poles, and special features shall be as indicated on Drawings. Horsepower rating of each starter shall be equal to or greater than motor horsepower. Starters for motor circuits rated at 208 volts and above shall be provided with a control circuit transformer, having a 120 volt secondary. Combination magnetic starters are permitted. Three-phase starters shall be furnished with three-element protection.
3. Manual across-line starters shall be furnished with manual reset thermal overload protective devices, including heating elements, start-stop-reset device or H.O.A. switch as indicated on Drawings, operable from front. Enclosure shall be NEMA Type 1 for indoor installation and NEMA Type 3R for outdoor installation or as indicated on the Drawings. NEMA size, voltage rating and number of poles shall be determined by motor horsepower, voltage and phase indicated on Drawings. Horsepower rating of each starter shall be equal to or greater than motor horsepower. Combination manual starters are permitted.
4. Thermal switch starters shall be tumbler type with plaster ears, binding screws for wiring, standard size composition cups which fully enclose mechanism, and shall be designed to fit standard outlet boxes. Thermal switches shall be fractional horsepower motor starters with thermal overload protective devices including heating elements and with handle providing on-off-reset control. Horsepower rating, voltage rating, and number of poles shall be determined from motor horsepower and voltage indicated on

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Drawings. Switches shall be key operated where so indicated on Drawings. Furnish one key with each key type switch. Horsepower rating of each switch shall be equal to or greater than motor horsepower.

5. Relays furnished for directly controlling motors shall be installed in NEMA Type 1 enclosure for indoor installations and NEMA Type 3R for outdoor installations, unless otherwise indicated or specified and shall be horsepower rated. Relay size, voltage rating and number of poles shall be determined from motor horsepower and voltage indicated on Drawings.

### **PART 3 – EXECUTION**

#### **3.01 INSTALLATION**

- A. Motor control centers installed outdoors, or below grade, shall be installed on a concrete pad as specified in Section 03 3000: Cast-In-Place Concrete, and as indicated on Drawings.
- B. Anchor bolts for freestanding equipment shall be designed to meet CBC seismic requirements. Equipment shall be anchored to concrete slab with anchor bolts. Provide structural drawings for Architect review prior to start of construction.
- C. Equipment shall be located so that it is readily accessible and not exposed to physical damage.
- D. Equipment locations shall provide sufficient working space around the equipment to comply with the California Electrical Code.
- E. Equipment installed outdoors shall be specifically approved for wet locations and shall be installed in a weatherproof NEMA Type 3R enclosure.
- F. Equipment shall be securely fastened to the mounting surface.
- G. Equipment enclosure shall be grounded to comply with Article 250 of the California Electrical Code.
- H. Conduits shall be installed so as to prevent moisture or water from entering and accumulating within the equipment enclosure.
- I. Lugs shall be suitable and permitted for installation with the conductor being connected.
- J. Conductor lengths shall be maintained to a minimum within the wiring space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- K. Maintain the required bending radius of conductors inside the cabinet.
- L. Distribute and arrange conductors neatly within the equipment space.

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- M. Tightening of wire lugs or any conductor connections shall be performed in the presence of the Project Inspector. Torque values shall be those recommended by manufacturer.
- N. Remove shipment blocks from component devices.
- O. Manually exercise switches and circuit breakers to verify they operate freely.
- P. Remove debris from equipment interior.
- Q. Follow manufacturer's instructions for installation.
- R. Furnish one spare fuse for each fusible switch installed. Spare fuses shall be of the same type and rating as those installed.
- S. Record Drawings: Submit project record drawings indicating the motor control center exactly as it was installed, including wiring diagrams of components.
- T. Installation Instructions: Submit manufacturer's written installation instructions, including recommendations for handling, protection and storage.
- U. Installation in corrosive environments such as boiler rooms, pool equipment, and other similar spaces is not allowed.
- V. Motor Control Center equipment and system components shall be free from short circuits and grounds, other than required grounds. The contractor shall be responsible for the testing of bolted electrical connections, perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one minute in accordance with requirements stated in NETA-ATS 2007 table 100.1. Test shall be performed in the following manner:
  - 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of bussing, circuit breakers and/or fused switches. The fused switches shall be equipped with fuses or temporary jumpers in place of fuses. Breaker and fused switches shall be tested in the closed position. No wiring shall be connected to the line or load side of the motor control center during testing.
    - a. Provide calibration program records to assure the testing instruments to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
    - b. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
    - c. Test reports shall include the following:
      - 1) Identification of the testing organization.
      - 2) Equipment identification.

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- 3) Ambient conditions.
  - 4) Identification of the testing technician.
  - 5) Summary of project.
  - 6) Description of equipment being tested.
  - 7) Description of tests.
  - 8) Test results.
  - 9) Analysis, interpretation and recommendations.
2. Perform test in the presence of the Project Inspector.
  3. During testing, provisions shall be made to prevent damage to any solid state components, or electronic equipment such as TVSS equipment that may be tied onto panel bussing.
  4. Test results shall meet manufacturer's recommendations or NETA ATS- 2007 recommendations, whichever is more stringent.

**3.02 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**3.03 CLEANUP**

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

**END OF SECTION**

**SECTION 26-5000 - LIGHTING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Lighting fixtures, including lamps, wiring, and lighting controls.
- B. Light fixtures model numbers were determined at the time this specification was written; model numbers may need to be modified, or may require the addition or deletion of options to fully meet specification requirements.
- C. Related Requirements:
  - 1. Division 01 – General Requirements.
  - 2. Section 26 05 00: Common Work Results for Electrical.
  - 3. Section 26 05 13: Basic Electrical Materials and Methods.
  - 4. Section 26 05 26: Grounding and Bonding.
  - 5. Section 26 05 19: Low-Voltage Wires (600 Volt AC or less).
  - 6. Section 26 09 23: Lighting Controls Systems.
  - 7. Section 32 1313 – Site Concrete Work.

**1.02 SUBMITTALS**

- A. List of Materials: Submit a complete list of materials proposed for this section.
- B. Shop Drawings: Provide detailed and dimensioned Shop Drawings indicating kind, weight and thickness of materials, method of fitting and fastening parts together, location and number of sockets, size of lamps, and complete details of method of fitting suspension and fastening fixtures in place. Provide wiring diagrams for lighting control equipment. Drawings shall contain sufficient information to assemble and install equipment at the Project site without further instructions.
- C. Prior to start of construction; provide photometric calculations with graphic of luminance levels of work plane, ceiling and walls of each rooms. Calculations shall comply with IESNA recommendations.
- D. Installation Instructions: Submit manufacturer's written installation instructions for fixtures and accessories.
- E. Light fixtures shall be Underwriters Laboratory (UL) or Nationally Recognized Testing Laboratory (NRTL) listed, and in compliance with applicable industry standards and codes.
- F. Submittals must comply with contract general provisions.

**1.03 MOUNTING REQUIREMENTS**

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- A. Design of lighting fixtures, accessories, supports, and method of fixture installation shall comply with requirements for earthquake-resistant construction of the State of California.
- B. Provide suspension points at no more than two feet from fixture ends. Spacing between supports shall not exceed eight feet.

### **1.04 QUALITY ASSURANCE**

- A. Components and fixtures shall be listed and approved for the intended application by Underwriter's Laboratories (UL), or other Nationally Recognized Testing Laboratory (NRTL).
- B. OWNER's written approval shall be obtained for any equipment or materials substitutions prior to their use.

### **1.05 GUARANTEE**

- A. Provide a two year labor warranty.
- B. Provide material warranty as specified:
  - 1. Lamps: two years.
  - 2. Standards: one year.
  - 3. Controls: three years.
- C. Warranty period begins at substantial completion or project acceptance for beneficial occupancy.

## **PART 2 - PRODUCTS**

### **2.01 MATERIAL AND FABRICATION**

- A. Lighting fixtures shall be the type indicated on Drawings and as specified. Fixtures of same type shall be of one manufacturer.
- B. Fixtures shall be of the types and manufacturers described in the LIGHTING FIXTURE SCHEDULE provided in the Electrical drawings, with lamps, wattage and voltage as indicated. Specific manufacturer and model number references are indicated as a standard of performance and quality; other manufacturers' models may be supplied provided the product meets or exceeds the specifications. The alternate fixtures shall achieve the same photometric levels and uniformity ratios.
- C. Fixtures shall be baked-on enamel or powder-coated, unless otherwise specified in subsections below.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

**Lighting - 265000**

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- A. Install a lighting fixture for each lighting outlet indicated and mark with day of installation.
- B. Fixture voltage shall be as indicated on Drawings.
- C. Install recessed and surface-mounted fixtures, with plaster frames compatible with ceiling and wall systems employed; secure fixtures mechanically to frames.
- D. Align rows of suspended and surface-mounted LED fixtures to form straight lines at uniform elevations.
- E. Recessed fixtures shall fit snugly against ceilings to prevent light leakage.
- F. Notwithstanding the following paragraphs in Part 3-Execution, fixture installations shall comply with the most current CBSC and Department of State Architect Seismic requirements.
- G. Support suspended recessed fixtures in accordance with DSA IR 25-2.10. Support pendant-mounted fixtures in accordance with DSA IR 16-9. Fixture installations shall be coordinated with acoustical and gypsum ceiling installation.
- H. Emergency light fixtures shall be labeled "Emergency Fixture" with one inch high letters produced with a P-touch or similar labeling system and shall be put on the housing.
- I. Continuous suspended fixtures:
  - 1. Fixture suspension device shall allow vertical adjustment of fixture without the use of tools. Cable shall be minimum seven strand twisted stainless steel capable of supporting minimum four times the fixture weight. For continuous linear suspended fixtures longer than eight feet, provide not less than three suspension points.
  - 2. Top of fixture shall be suspended as shown on the Drawings.
  - 3. Fixture shall utilize factory furnished or approved hardware and canopy for either hard or T-bar ceilings.
- J. Where fixtures with emergency battery packs are installed, these fixtures shall receive constant powered circuits. When powering unit inverter power packs, use the same circuit that powers the switched ballast to power the inverter.
- K. Surface mount fixtures shall be attached to structure. Toggle bolts shall NOT be used or permitted. Provide backing supported by structure where required.

### 3.02 TESTING

- A. Check and adjust fixtures for required illumination.
- B. Test and adjust lighting control equipment for proper operation.

### 3.03 SPARE PARTS

Provide the following spare parts:

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- a. Furnish 5% spare lamps with a minimum of one spare lamp of each type.
- b. Furnish 5% spare motion detectors of each type with a minimum of one spare detector of each type.

**3.04 HAZARDOUS WASTE DISPOSAL**

- A. Hazardous waste disposals and recycling shall be handled and disposed of by an approved, licensed CONTRACTOR.
- B. Store, remove, transport and dispose of hazardous materials in all accordance with state and federal regulations.
- C. Provide OWNER with copy of manifest and certificate of destruction and/or recycling no later than achievement of substantial completion.

**3.05 PROTECTION**

- A. Protect the Work of this section until Substantial Completion.

**3.06 CLEANUP**

- A. Remove rubbish, debris, and waste materials from all areas of work each day.
- B. Clean fixture surfaces of dirt, cement, plaster and debris. Furnish cleansers compatible with material surfaces being cleaned.

**END OF SECTION**

## **SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. Section includes, but is not necessarily limited to:
  - 1. Common standards and procedures for the Communications Work.
    - a. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of the Work of this Division. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction.
- B. Provisions of this Section apply to Communications Work, including the following Sections:
  - 1. Section 27 05 26 - Grounding and Bonding for Communications Systems
  - 2. Section 27 05 29 - Hangers and Supports for Communications Systems
  - 3. Section 27 05 33 - Conduits and Backboxes for Communications Systems
  - 4. Section 27 05 36 - Cable Trays for Communications Systems
  - 5. Section 27 05 39 - Surface Raceway for Communications Systems
  - 6. Section 27 05 48 - Noise and Vibration Controls for Communications Systems
  - 7. Section 27 05 53 - Identification for Communications Systems
  - 8. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
  - 9. Section 27 11 13 - Communications Entrance Protection
  - 10. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
  - 11. Section 27 11 19 - Communications Termination Blocks and Patch Panels
  - 12. Section 27 11 23 - Communications Cable Management
  - 13. Section 27 13 00 - Communications Interior Backbone Cabling
  - 14. Section 27 14 00 - Communications Outside Plant Backbone Cabling
  - 15. Section 27 15 00 - Communications Horizontal Cabling

#### **1.02 REFERENCES**

- A. Usage: In accordance with Division 1.
- B. American National Standards Institute (ANSI)
  - 1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
  - 2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
  - 3. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
  - 4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2018, plus errata issued in October, 2008.
  - 5. TIA-569-C (2012) Telecommunications Pathways and Spaces
  - 6. ANSI/TIA-606-B-2012, Administration Standard Telecommunications Infrastructure.
  - 7. ANSI-J-STD-607-B, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
  - 8. ANSI/TIA-758-A, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
- C. BICSI
  - 1. Telecommunications Distribution Methods Manual (TDMM) - 12th edition.

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2. BICSI - Outside Plant Design Reference Manual (OSPDRM) - 4th edition.
3. BICSI - Wireless Design Reference Manual (WDRM) - 3rd edition.

### 1.03 DEFINITIONS

- A. See also Division 1.
- B. General Abbreviations used in these specifications. Refer additionally to the abbreviations list appearing on the Drawings.
  1. ADA Americans With Disabilities Act.
  2. AFC Above Finished Ceiling.
  3. AFF Above the Finished Floor.
  4. BLDG Building
  5. CAT Category
  6. CL Centerline
  7. DIV Division
  8. (E) Existing
  9. FBD Furnished By District
  10. HR Home Run
  11. ID Inside Diameter
  12. LAN Local Area Network
  13. MAX Maximum
  14. NIC Not In Contract.
  15. OD Outside Diameter
  16. PSRH Project Standard Receptacle Height.
  17. PSSH Project Standard Switch Height.
  18. TYP Typical
  19. OFE District Furnished Equipment.
  20. UON Unless Otherwise Noted.
- C. Electrical and electronics terms used in the Communications Sections shall be as defined in:
  1. ANSI/TIA-568-C.0
  2. ANSI/TIA-568-C.1
  3. ANSI/TIA-568-C.2
  4. ANSI/TIA-568-C.3
  5. ANSI/TIA-569-C
  6. ANSI/TIA-606-B
  7. IEEE Std 100
  8. This Section.
- D. Main Distribution Facility (MDF): Is a campus serving facility. The MDF is the room within a building for telecommunications equipment that meets the voice, data, video, radio, and wireless needs of its building and also serves other buildings on campus. It generally acts as an EF and BDF but can also act as an IDF serving the floor it occupies.
- E. Intermediate Distribution Facility (IDF) - A distributor used to connect horizontal cable and cabling subsystems or equipment.
- F. Telecommunications Room (TR) - The term TR refers to space allocated within a building to provide a secure operating environment for telecommunications cabling and termination facilities and/or network equipment. TRs shall be designed and provisioned

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per

ANSI/TIA-569-C 5. Telecommunications Pathways and Spaces and per the BICSI Telecommunications Distribution Methods Manual (TDMM), most recent edition. Depending on the building size, design, and network requirements, one or more of the functions of a TR may be combined into one space. The primary functions housed in TR's are:

1. Entrance Facility (EF).
  2. Intermediate Distribution Frame (IDF).
  3. Main Distribution Frame (MDF).
- G. Entrance Facility (EF) (Telecommunications) Is a room that houses the termination and grounding point of OSP network service cables that enter or exit a building. It enables the joining of intra-building and inter-building backbone cabling. The EF is generally co-located in a BDF or MDF rather than being a separate room
- H. Entrance Room (ER) (Telecommunications) - A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.
- I. Open Cable - Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is open to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.
- J. Open Office - A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.
- K. Pathway - A physical infrastructure utilized for the placement and routing of telecommunications cable.
- L. Reference to Named Products
1. Selected Item: Item so noted was selected based on comparative testing of similar products. Procedure for determination of equivalence is noted in the specification for the item(s).
  2. System Design Basis: Item so noted interacts with other system items to produce total system function. Substitution of this item may require coordinated substitution of other system items.
  3. Design Basis: Item so noted was used as basis for system drawings to establish features, size, etc. Use of specified equivalents may require adjustment of physical layout or wiring, but does not affect system function. No preference is implied.

#### **1.04 SUBMITTALS**

- A. Comply with Division 1 and the following.
1. Submit all materials for review arranged in same order as Specifications, individually referenced to Specification Section, Paragraph and Contract Drawing number. Conform in every detail as applies to each referencing Section.
  2. Submit 8 ½"x 11" items bound in volumes and drawings in edge bound sets. Submit all drawings on sheets of the same size.
  3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
  4. Progress Schedule: Comply with Division 1.

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- B. Contractor and Key Personnel Experience.
1. A minimum of 30 days prior to installation, submit documentation of the experience of the low voltage systems, equipment and infrastructure contractor(s) and of their key personnel.
  2. Qualifications shall be provided for:
    - a. the low voltage systems, equipment and infrastructure contractor(s),
    - b. the low voltage systems, equipment and infrastructure installers,
    - c. and the supervisor(s) (if different from the installers).
  3. A copy of the Contractor's C-7 license or C-10 licenses - both if Contractor has both.
  4. A copy of testing personnel certification(s) that demonstrate that the proposed personnel have the necessary training and certifications to conform with the proof of performance testing requirements of this Division and that they are properly trained in the use of the testing equipment that will be employed by the contractor.
  5. Copies of Contractor's Structured Cabling System (SCS) manufacturer's authorized vendor/installer Certification document(s).
  6. Refer to Quality Assurance paragraph in this section for complete requirements.
- C. Manufacturer's Product Data:
1. Manufacturer's Product Data Sheets. Collate in sequence of List of Materials:
  2. Data sheet for each item in each Communications Section, including all accessories, clearly marked for proposed product.
  3. Material Safety Data Sheet, where applies.
  4. List of Materials Schedule. For each item, include:
    - a. Referencing Specification Section
    - b. Referencing Paragraph
    - c. Referencing Drawing, if specified only on plan
    - d. Manufacturer.
    - e. Model number.
    - f. Listing, including name of Nationally Recognized Testing Laboratory.
    - g. Precede each submittal book with a summary schedule, with columns for each item above and rows for each item submitted, per the example schedule below:

Specification Section	Paragraph	Contract Drawing Reference	Manufacturer	Model No.	UL/ETL/CLA Listed
27 05 00	2.03C		XYZ	123	Y
27 15 00	2.07A1		AAA	34-56	Y
		T0.1	ZZY	456	Y

- D. Field (Installation) Drawings:
1. General
    - a. Drawings shall present the proposed installation using the makes and models of devices proposed for use this project; replace vendor neutral nomenclature used in bid set with the actual part numbers to be installed or provide a lookup table in the drawings to permit determining the actual part number.
    - b. Where the existing systems and/or infrastructure are used and integrated into the work of the project, indicate them on drawings, including points of

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- interface and demarcation of existing and new work.
- c. Collate, in sequence, at least the following minimum drawings, for each infrastructure and system to be installed under the work of this contract:
- 2. Drawing index/symbol sheet.
- 3. Site plans, floor plans and reflected ceiling plans.
  - a. General
    - 1) The identifier for each termination and cable shall appear on the drawings, either directly on the floor plans, through an associated schedule or a unique identifier associated with a fully annotated single line diagram.
    - 2) Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
    - 3) At scale of Contract Documents, show:
      - (a) Device locations and type
      - (b) Rough-in.
      - (c) Mounting height.
      - (d) Conduit size.
      - (e) J-hook routes
      - (f) Wire type.
      - (g) Wire fill.
    - 4) On the floor plans, indicate floor and wall mounted devices and pathway below a height of 7 feet above finish floor. Indicate the locations of the communications rooms and provide reference to the enlarged communications rooms plans.
    - 5) On the reflected ceiling plan, indicate ceiling and wall mounted devices and pathway above a height of 7 feet above finish floor. Indicate the locations of the communications rooms and provide reference to the enlarged communications rooms plans.
  - b. Communications Infrastructure
    - 1) Provide registered communications distribution designer (RCDD) approved, drawings depicting a complete communication infrastructure in accordance with ANSI/TIA-606-B. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the communications rooms including EF, ER, CD's, BD's, and FD's to the telecommunications work area outlets.
    - 2) The following drawings shall be provided as a minimum:
      - (a) T1- Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.
      - (b) T-2 Serving Zones/Building Area Drawings - Drop Locations and

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Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

- (c) A complete jack numbered plan set in FUSD jack numbering format in printed and AutoCAD format. Number plans with all jacks for each floor indicated on a single drawing sheet. Data, voice, wireless and security jacks shall appear on the same page. Symbols shall be indicated for the data, wall phone, wireless, inside camera, outside camera, as applies. A four digit jack numbers shall be printed by each jack symbol. Jack plan shall be approved by the District before the cabling begins.

4. Enlarged Plans

a. General

- 1) Indicate at least as much information as is provided in the Contract Documents, supplemented by the dimensions and arrangement of the proposed equipment, trade coordination and field conditions.

b. Communications Infrastructure.

1) Communications Rooms Drawings

- (a) Provide T3 drawings in accordance with ANSI/TIA-606-B that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, rack, backboard and wall elevations. Include rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.
- (b) At scale of Contract Documents, the Contractor shall submit scaled drawing elevations (showing dimensions, mounting locations and associated frames & equipment) for all required assemblies, including but not limited to:
  - (1) Rack locations
  - (2) Wall mounted plywood backboards
  - (3) Wall mounted backbone cabling and major station cable bundles.
  - (4) Wall mounted and tray mounted splice cases
  - (5) Wall mounted copper cable protectors and terminal blocks.
  - (6) Wall mounted fiber optic cable terminations.
  - (7) Clearances
  - (8) Backboard Wire and Cable Management
  - (9) Rack elevations, including
  - (10) Copper cable patch panels.
  - (11) Fiber optic cable patch panels.
  - (12) Rack mounted wire managers
  - (13) Hold clears for equipment provided by Others.
  - (14) Reference to mounting details.
  - (15) Power strips
  - (16) UPS

- 2) Drawings may also be an enlargement of a congested area of T1 or

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T2 drawings.

5. System Conduit and Riser Diagrams,
  - a. General:
    - 1) Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment.
    - 2) Single line diagram of structured wiring
    - 3) Grounding and bonding scheme
    - 4) Terminal cabinets.
    - 5) Coordination with floor plans.
    - 6) Wire runs not shown on floor plans.
    - 7) Wire type.
    - 8) Wire fill.
    - 9) Interface to work provided by work of other Sections, District  
Furnished Equipment, existing equipment and/or future equipment.
6. Detail Drawings
  - a. Mounting details:
    - 1) Conform with DSA approved mounting details provided in the Contract Documents.
  - b. Faceplate and Receptacles
    - 1) Receptacle and jack arrangement for each condition.
    - 2) Labeling of receptacle/jacks and plate
    - 3) Plate material.
    - 4) Plate finish.
    - 5) Connector types.
    - 6) Connector dimensioned layout.
  - c. Pathway
    - 1) Cable tray installation details, indicating complete system of fittings and radiussed pathways provided.
    - 2) Firestopping. Listed fire stop system documentation supporting proposed systems ability to conform with the project requirements.
    - 3) Penetrations. All conduit and piping wall, ceiling, floor, and roof penetrations, including both fire rated or non-rated, should be submitted for review prior to installation.
      - (a) For cored penetrations through concrete partitions, submit proposed work plan in the form of Coring/Sawcutting Summary Description as described in Section 27 05 33 - Conduits and Backboxes for Communications Systems.
    - 4) Details of flexible raceway connections to be made to vibrating equipment
    - 5) Details of J-Box and sealant application for the typical conditions listed in Section 27 05 48 - Noise and Vibration Controls for Communications System, and a schedule of rooms to receive application of mastic and sealant at J-Boxes
    - 6) An itemized list of all items of equipment to be fitted with flexible electrical connections.
    - 7) Conduit racking details.

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- d. California Access Compliance Manual and Americans with Disabilities Act (ADA) compliance.
  - e. Terminal cabinets: Terminations.
- E. Schedule Submittals.
  - 1. An Excel spreadsheet listing jack number, floor number, room number and jack type (workstation, wireless, camera, emergency phone, etc.)
  - 2. Voice cable plant: Cut sheets for use by District's Telephone Systems Contractor.
- F. Samples
  - 1. Mock-ups of each type of communications outlet faceplate to be furnished for this project. Each faceplate mock-up shall contain the following:
    - a. Full load of required connectors with eighteen inches (18") of connector type appropriate specified cable terminated on each connector.
    - b. Required faceplate labeling to include faceplate icons as required by these Division 27 Specifications and the accompanying construction drawing set.
- G. Cabling and Equipment Test Plan
  - 1. Submit complete documentation of the proposed test plan and equipment to be used to document that the performance of the cabling, equipment, sub-systems and complete systems installed under the work of this project conform with the performance standards outlined in each specification section.
  - 2. Submit not less than 45 days prior to the proposed test date. Include procedures for certification, validation, and testing.
  - 3. Submit manufacturer's or recognized national test laboratory's calibration certificate one (1) month before any post-installation testing begins. Date on test unit calibration certificate shall be no longer than one (1) year prior to the date that post-installation testing is scheduled to begin.
  - 4. Submit a copy of the Test Equipment manufacturer's recommended testing procedure for each of the structured cabling system elements listed above in this section.
- H. Test Reports
  - 1. Manufacturer's Field Reports
    - a. Factory reel tests
  - 2. Project Site Test Reports:
    - a. Submit following system completion and prior to and as condition precedent to Acceptance Review and Testing of the Work of this Section.
    - b. Schedule: Submit test reports in timely manner relative to Project schedule such that the District's Representative may conduct verification of submitted test data without delay of scheduled progress.
    - c. Provide test reports as specified within each section of Division 27 requiring performance testing.
    - d. Content: Include at least:
      - 1) Time and date of test.
      - 2) Personnel conducting test.
      - 3) Test equipment, including serial and date of calibration.
      - 4) Test object.
      - 5) Procedure used.
      - 6) Results of test

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- 7) Numerical or graphical presentation.
- e. Submit copy of final results on paper and in electronic form, organized by circuit number, consistent with circuit numbering scheme used in preparing submittal drawings and in labeling receptacles and terminations.
  - 1) Submit machine-generated documentation and raw data of all test results in electronic form on CD-R media
  - 2) Where the electronic documentation requires use of a proprietary computer program to view the data, provide the District with 1 licensed copy of the software.

#### **1.05 QUALITY ASSURANCE**

- A. Procedures: In accordance with Section 01 43 00 - Quality Assurance.
- B. Designated Supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual through the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.
- C. Reference Documents: At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies.
  1. A complete set of the latest stamped, actioned submittals of record.
  2. A complete set of manufacturer's original operation, instruction and service manuals for each equipment item.
- D. Standard Products
  1. Telecommunications Equipment. Provide telecommunications materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 1 year prior to bid opening. The 1-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 1-year period.
    - a. Alternative Qualifications. Products having less than a 1-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 4000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
  2. Material and Equipment Manufacturing Date
    - a. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.
- E. Test Equipment
  1. Requirements:
    - a. Maintain and operate test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section.
    - b. Maintain test equipment at the job site while work is in progress from installation of equipment racks until District's Acceptance of this Work; thereafter remove all of this test equipment from the job site.
    - c. Unless otherwise indicated, test equipment shall remain property of the Contractor.

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- d. Provide all required test cables, jigs and adapters.
  - e. Provide equipment with traceable calibration, with calibration date not greater than one year prior to the date of the use of the equipment to perform the specified testing.
- F. Qualifications
  - 1. Key Personnel, General
    - a. Indicate the proposed key persons that are currently employed by the telecommunications contractor or who have a commitment to the low voltage systems and infrastructure contractor for the work of this project. All key persons shall be employed by the low voltage systems and infrastructure contractor at the date of issuance of this project, or if not, have a commitment to the low voltage systems and infrastructure contractor to work on this project by the date that the bid was due to the District's Representative.
    - b. Note that only the key personnel approved by the District's Representative in the successful proposal shall perform work on this project's low voltage systems and infrastructure systems. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the low voltage systems and infrastructure contractor's key personnel requires approval from the District's Representative.
  - 2. Telecommunications Contractor
    - a. The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment.
      - 1) The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years.
      - 2) Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.
    - b. Key Personnel
      - 1) Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this project depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.
      - 2) Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.
      - 3) In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for

a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this project. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this project. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity

3. Minimum Communications Infrastructure Manufacturer Qualifications
  - a. Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with ANSI/TIA-568-C.1, ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3.

#### **1.06 REGULATORY REQUIREMENTS**

- A. Regulations Applicable: Including but not limited to those defined in Division 1.
  1. Nothing in the Contract Documents shall be construed to permit Work not conforming to applicable laws, ordinances, rules, or regulations.
  2. Safety Agency Listing: All devices provided under the Work of this Section which are connected to the Project electrical system shall be listed by a Nationally Recognized Testing Laboratory, and shall be so labeled.
  3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the District's Representative. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

#### **1.07 DELIVERY, STORAGE AND HANDLING**

- A. Procedures:
  1. In accordance with Division 1, as specified in the individual sections of Division 27 and the following.
- B. General
  1. Protect materials and equipment from damage during delivery, storage, handling and throughout the staging and construction periods. Equipment and materials shall be  
  
protected against physical damage, dirt, theft, sun, moisture (including surface water and precipitation) and extreme temperature.

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2. The top and bottom ends of all cable shall be available for testing. When not being prepared for testing, both ends of each cable shall be sealed to prevent the ingress of moisture.
3. Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.
4. Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.
5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
6. As determined by the District's Representative, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. The decision of the District's Representative shall be final.
7. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
8. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

### **1.08 ENVIRONMENTAL REQUIREMENTS**

- A. Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, non-condensing.

### **1.09 SEQUENCING**

- A. Not Used.

### **1.10 OPERATING AND MAINTENANCE DATA**

- A. Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the communications cabling and systems. Precede the manuals with a systems narrative specific to this Project, outlining the major systems functionality, the major systems components, and identifying which manuals document the performance of which subsystems.
  1. Submit operations and maintenance data in accordance with Section 01 77 00 - Closeout Procedures and 01 78 00 - Closeout Submittals and as specified herein not later than 2 weeks prior to the date of beneficial occupancy or as specified in Division 1, whichever is sooner.

### **1.11 PROJECT RECORD DOCUMENTS**

- A. Comply with Section 01 77 00 - Closeout Procedures, Section 01 78 00 Closeout Submittals, and the following. Include at least as much information as required for the submittal drawings.
  1. Record Drawings
    - a. CAD.
      - 1) Use a computer aided drafting (CAD) system in the preparation of record

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- drawings for this Project. CAD system shall produce files in AutoCAD® .DWG format, version 2004 or later.
- b. Except where prohibited by Contract, District will furnish CAD backgrounds in AutoCAD® .DWG format, for use by the Contractor in preparing Record Drawings.
  - c. Contractor shall be responsible for updating building and communications plans to reflect as-built conditions.
    - 1) Indicate actual work on Drawings; indicate actual products used, replace vendor neutral nomenclature used in bid set with makes and models of actual installed devices.
  - d. Disk copy of Record Drawings: Two (2) sets of CDs or DVDs of the as-built drawings.
  - e. Reproduceables: As required by Division 1
2. Provide T5 drawings including documentation on cables and termination hardware in accordance with ANSI/TIA-606-B. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. Provide the following T5 drawing documentation as a minimum:
- a. Cables - A record of installed cable shall be provided in accordance with ANSI/TIA-606-B. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with ANSI/TIA-606-B. Include manufacture date of cable with submittal.
  - b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with ANSI/TIA-606-B. Documentation shall include the required data fields as a minimum in accordance with ANSI/TIA-606-B.
  - c. The list of minimum required Project Record drawings is as follows:
    - 1) All cabling outlets with IDs for each connector on the faceplate;
      - (a) Two inch (2") and larger conduit pathways to include conduit size label;
      - (b) Pull box locations;
      - (c) Two inch (2") & four inch (4") J hook runs indicated by a line series of "x"s;
      - (d) Telecom room layout labeled per current construction drawing field mark-ups;
      - (e) Rack elevation labeled per current construction drawing field mark-ups;
      - (f) Backbone copper and fiber schematic drawings with labeling information
3. Record of Cable Plant Test
- a. Two (2) sets of CDs or DVDs of final District accepted cable plant testing results documentation.
  - b. Provide at least a copy of software with at least 1 user license if required to view submitted test data.
4. Penetrations
- a. All penetrations provided under the work of the project, including fire rated and non fire rated.

5. Fire stopping
  - a. Two (2) sets of CDs or DVDs of all fire stop graphical UL fire resistance manual reference drawings and supporting text.
6. Spare Parts
  - a. In addition to the requirements of Section 01 77 00 - Closeout Procedures, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

#### **1.12 WARRANTY SERVICE**

- A. In addition to provisions of Division 1, provide the following.
  1. Response Time: Provide a qualified technician familiar with the work at the Project Site within 24 hours after receipt of a notice of malfunction. Provide the District's Representative with telephone number attended 8 hours a day, 5 days a week, to be called in the event of a malfunction.
- B. The Contractor shall provide a one (1) year material and labor warranty on all the work the Contractor has performed.
- C. The Contractor shall provide the Structured Cabling System (SCS) manufacturer's materials and link performance certification warranty for all new cable installed by the Contractor in his execution of the work of this specification.
- D. Provide all additional Warranties as defined in each Communication Systems Section.

#### **1.13 ACCEPTANCE REVIEW AND TESTING PROCEDURES**

- A. Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the District's Representative  
  
in writing that the Work of these Sections is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing. The District's Representative will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These procedures may be performed at any hour of the day or night as required by the District's Representative to comply with the Project Schedule and avoid conflict with Residents. Provide all specified personnel and equipment at any time without claim for additional cost or time.
- B. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this Section. Provide quantity of technicians as required to comply with Project Schedule.
- C. In Addition, Provide:
  1. All tools appropriate for performance of adjustment of and corrections to this Work. Include spare wire and connectors and specified tooling for application.
  2. Ladders, scaffolding and/or lifts as required to access high devices.
  3. All test equipment.
  4. Complete set of latest stamped, actioned submittals of record for reference.
  5. Complete set of Test Reports.
  6. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
  7. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.

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- 8. Adjust: As directed by the District's Representative.
- 9. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the District's Representative.
- D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the District's Representative, in place of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven (7) days prior to the scheduled completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.

### 1.14 CLOSEOUT

- A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify the District's Representative of completion of Punch List.
- B. Portable Equipment: Furnish all portable equipment and spares to the District's Representative, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.
- C. Operating and Maintenance Data: Install framed operating and maintenance instructions. Submit Manuals.
- D. Project Record Documents: Submit print and digital copies. Digital files shall be in AutoCAD .dwg format.
- E. Keys: If applicable, replace construction locks with permanent locks. Provide 5 sets of keys to the District's Representative.
- F. Instruction: Conduct specified instruction.
- G. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail.
- B. Each material, device or piece of equipment shall comply with all of the manufacturer's current published specifications for that item.
- C. Products shall be made by manufacturers regularly engaged in the production of such products.
- D. Provide quantity as shown on Contract Drawings, or as otherwise indicated.
- E. Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.
- F. Unless recycled content is specified, provide new materials.
- G. Provide the manufacturer's latest design/model, permanently labeled with the manufacturer's name, model number and serial number.
- H. Where products are of similar type or use, provide products of the same manufacturer,

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unless otherwise indicated. When more than one unit of the same type of equipment or material is required, such units shall be the products of a single manufacturer and part number.

- I. Components
  - 1. UL or third party certified. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.
  - 2. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance.
    - a. The label or listing by the specified organization will be acceptable evidence of compliance.
    - b. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the District's Representative.
    - c. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- J. Enclosures:
  - 1. Provide steel frames and enclosures designed and wired to eliminate all induced currents.
  - 2. Make bolted connections with self-locking devices.
- K. Finishes: Any item or component of the Work of this Section which is visible shall comply with the following.
  - 1. Finishes noted or scheduled on the Contract Drawings take precedence.
  - 2. Where design location requires that products, materials or equipment are visible to the public, no manufacturer's logos larger than 1/2 inch shall be visible. Unless otherwise noted or directed, neatly remove or permanently paint out such logos.
  - 3. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the District's Representative.

## **PART 3 EXECUTION**

### **301 INTENT OF DRAWINGS AND SPECIFICATIONS**

- A. Contractor shall keep on the Project site a copy of the Specifications and Drawings, and the same shall be available at all reasonable times for inspection and use by The District's Representative and by any other person authorized by The District's Representative. Any Drawings listed in the detail Specifications shall be regarded as a part thereof and of the Contract. Anything mentioned in these Specifications and not shown on the Drawings, or shown on the Drawings and not mentioned in these Specifications, shall be of like effect as though shown or mentioned in both.
- B. It shall be the duty of Contractor to see that the provisions of these Specifications are complied with in detail irrespective of the inspection given the work during its progress by The District's Representative. Any failure on the part of Contractor to observe the Specifications will be sufficient cause for the rejection of the work at any time before its acceptance.

- C. The drawings use symbols and schematic diagrams to indicate the scope of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Contractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed in accordance with the intent diagrammatically expressed on the drawings and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the District's Representative.
- D. The drawings include some details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Contractor.
- E. The District's Representative will furnish from time to time, such detail drawings, drawings, profiles, and information as The District's Representative may consider necessary for Contractor's guidance to insure the proper and adequate execution of the Contract. Contractor shall comply with such detail drawings, drawings, profiles and information.
- F. In accordance with the requirements of Division 1, only shop drawings and submittals have been received a review of "No Exceptions Taken" or "Make Corrections As Noted" shall be used in construction.
- G. Contractor shall not scale the Contract Document set to determine exact dimensions or exact location. Scaled drawings are to be considered diagrammatic. If exact lengths or location placement dimensions are required, the drawings will specifically show those dimensions or placement coordinates.

### **3.02 INSTALLATION**

- A. The Contractor shall furnish all required materials, equipment, and tools necessary to properly complete the work of these specifications including, but not limited to, tools for pulling and terminating the cables, mounting hardware, cable ties, bolts, anchors, clamps, hangers, kits of consumables, lubricants, technician communication devices, cable testing equipment, stands for cable reels, cable wenchers, etc.

### **3.03 EXAMINATION**

- A. The Contractor is responsible for examining existing conditions and comparing them with drawings and specifications and notifying the District Representative or his/her designate of any discrepancies.
- B. The Contractor is responsible for coordinating with the District Representative or his/her designate to address, adjust, and resolve any discrepancies found before commencing work.
- C. If a discrepancy between existing conditions and the Contract drawings and specifications are found after commencing work, stop any work that in the Contractor's opinion is affected by the found discrepancy. The contractor shall submit an RFI requesting information on how to resolve the discrepancy. The RFI shall also contain a possible solution, before commencing work in work areas affected by the discrepancy.

### **3.04 PREPARATION**

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- A. Prepare and sequence the work to minimize disruption to each room environment and existing communications systems.
- B. The Contractor shall follow all rules, regulations, and instructions in this specification, general provisions of the Contract, including General and Supplementary Conditions, and Division 1 specification sections, if issued in conjunction with these Division 27 specifications with regard to the following:
  - 1. Delivery hours.
  - 2. Delivery locations.
  - 3. Storage.
  - 4. Hazardous Material.
  - 5. Security
  - 6. Safety.
  - 7. Logistics.
- C. The Contractor shall coordinate their work so there shall be no disruption to any occupants of a FUSD campus unless coordinated and approved by the District's Representative. Any necessary disruption shall be scheduled a minimum of 2 weeks in advance of its occurrence and affected parties shall be notified in writing of date, time, and planned duration of the disruption.
- D. Protection:
  - 1. When work is being done in or adjacent to occupied spaces, the Contractor shall protect the occupied spaces from dust, trash and debris through the use of barriers and/or other devices
  - 2. When working in occupied spaces, cover all computers, electronic equipment, desks, chairs, furniture and other articles when working at ceiling level and/or performing dust producing tasks.
  - 3. At no time shall the Contractor use District property including but not limited to the District's furniture, loose equipment or supplies located in occupied spaces in the course of installing the work of this project.

### 3.05 CLEANING

- A. When working in spaces not currently occupied by the District's personnel during ordinary work week:
  - 1. Work areas shall be left broom clean at the end of each work day. This includes the removal of packing material, trash and debris caused by the work.
- B. Where working in spaces occupied by the District:
  - 1. Immediately after completing work within each space, clean up and remove all materials, scrap and dust.
  - 2. Surfaces exposed to dust either during the installation or following removal of protection systems as specified herein above shall be cleaned to their original state daily prior to the return of the occupants to the space.
  - 3. All dust resulting from work performed shall be vacuumed up daily prior to the return of the occupants to the space.
- C. Disposal
  - 1. All scrap material in work area shall be picked up and removed from the building at the end of each day..

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2. See Division 1 for additional requirements and project procedures for waste disposal and recycling requirements that apply to this project.

### **3.06 REPAIR AND RESTORATION**

- A. Where working in spaces occupied by the District, return to their original positions any furniture or articles relocated to perform the work.

### **3.07 VERIFICATION**

- A. The Contractor shall verify that the installation and materials used have been inspected before they are enclosed within building features, or otherwise hidden from view. The Contractor shall bear costs associated with uncovering or exposing installations or features that have not been inspected and approved.
- B. The Contractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
  1. Verification by Inspection. Verification by inspection includes the examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the District.
- C. Verification by Test and Demonstration. The Contractor shall verify by formal demonstrations or tests that the requirements of this specification have been met. The Contractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the System Operation Test. Even though no formal environmental testing is required, the Contractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the System Operation Test.

### **3.08 COMMISSIONING AND ACCEPTANCE**

- A. General:
  1. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
- B. Results Expected:
  1. Communications Infrastructure Systems shall be complete and ready for use.
  2. Testing, start-up and cleaning work shall be complete.
  3. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the District.
- C. Inspections
  1. There shall be three phases of commissioning inspections:
    - a. Rough-in inspection
    - b. Above-ceiling inspection (after cables are placed)
    - c. Final inspection and testing
  2. The Contractor shall verify that the installation and materials used have been inspected before they are enclosed within building features, or otherwise hidden from view. The

Contractor shall bear costs associated with uncovering or exposing installations or features that have not been inspected and approved.

- D. Rough-in inspection. Once electrical rough-in and pathways have been installed, but prior to walls and ceilings being installed, the Contractor shall request the design team, in writing, for the official rough-in inspection to take place. The District's Representative will then schedule a time to be on-site to conduct this inspection.
  - 1. At a minimum, the District's Representative will evaluate the following items:
    - a. Accurate location and height above finished floor for all outlet boxes.
    - b. Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.
    - c. Cable tray size, location, and clearance.
    - d. Location and size of all other communications conduits or pathways.
    - e. Location, spacing and clearance of and around racks and wall-mounted equipment.
    - f. That communications room power receptacles, where installed under the work of this project, meet the design requirements.
  - 2. The District's Representative is then to issue a written report to the Contractor identifying all items which currently do not meet the construction document requirements. All items are to be resolved prior to walls and ceilings being closed up. This report is not necessarily all-inclusive; should issues be discovered later in the project, the Contractor is still responsible for corrections/repairs.
- E. Above-ceiling inspection
  - 1. Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, contractor shall request of the design team, in writing, for the official above-ceiling inspection. The District's Representative will then schedule a time to be on-site to conduct this inspection
  - 2. At a minimum, the District's Representative will evaluate the following items:
    - a. That all items from the previous inspection have been corrected.
    - b. That communications cabling is routed correctly and adequately supported.
    - c. That communications cabling is not painted or over-sprayed.
    - d. That the installed communications cabling matches what was specified/submitted.
    - e. That there are no kinks, splices, or other damage to the installed communications cabling.
    - f. That all cables and WAOs are properly labeled.
    - g. That all penetrations through fire-rated walls are properly firestopped, including fire blocking materials installed in the annular spaces; and that the firestops are properly labeled.
  - 3. The District's Representative is then to issue a written report to the Contractor identifying all items which currently do not meet the construction document requirements. This report is not necessarily all-inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.
- F. Final inspection.
  - 1. Once all communications work has been completed, contractor shall request of the District's Representative, in writing, the official final inspection. This request shall be

- made 3 weeks before substantial completion. The District's Representative will then schedule a time to be on-site to conduct this inspection.
2. At a minimum, the District's Representative will check the following items:
    - a. That all items from the previous inspections have been corrected.
    - b. That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme.
    - c. That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.
    - d. And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.
    - e. That all cables and WAOs are properly labeled.
    - f. That all penetrations through fire-rated walls are properly firestopped, including fire blocking materials installed in the annular spaces; and that the firestops are properly labeled.
  3. The Contractor shall provide the following for the acceptance testing.
    - a. All personnel required for perform the tests. This shall include the site supervisor.
    - b. All tools appropriate for performance of adjustment of and corrections to this Work. Include spare wire and connectors and specified tooling for application.
    - c. Ladders, scaffolding and/or lifts as required to access high devices.
    - d. All test equipment.
    - e. Complete set of latest stamped, actioned submittals of record for reference.
    - f. Complete set of Test Reports.
    - g. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
  4. The Contractor shall execute the test plan required in the above Submittals section and as approved and/or modified by the District's Representative. The testing must demonstrate complete operation of all systems and equipment, including any portable equipment.
  5. These procedures may be performed at any hour of the day or night as required by the District's Representative to comply with the Project Schedule and avoid conflict with Residents. Provide all specified personnel and equipment at any time without claim for additional cost or time.
  6. After installation, the Contractor shall test, certify and provide required warranties for the Structured Cabling System (SCS) installed per the requirements of this specification.

### **3.09 ADJUSTMENTS**

- A. The Contractor is responsible for coordinating and documenting with the District Representative or his/her designate the change order process and fully comply with requirements of Division 1.

### **3.10 ACCEPTANCE**

- A. The project specified by this specification shall be considered completed and signed off as completed by the District Representative or his/her designate contingent upon the following:

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1. All punch lists have been completed and signed as complete by the District's Representative.
2. Abandoned cabling has been removed.
3. Cleaning is complete.
4. Required cable plant testing has been executed and required test result documentation has been submitted and approved by the District Representative or his/her designate - refer to Section 27 10 00 - Structured Cabling, Basic Materials & Methods
5. Any required adjustments to as-built drawings have been completed, submitted, and approved as complete by the District Representative or his/her designate.
6. Required warranty documentation has been submitted and approved as complete by the District Representative or his/her designate.

**END OF SECTION**

**Common Work Results For Communications - 270500**

**SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS PART 1**  
**GENERAL**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

- A. Section includes grounding and bonding of Communications Work, including but not limited to:
  - 1. Communications Raceways
  - 2. Cable Runway
  - 3. Cable Shields
  - 4. Protector Fields
  - 5. Communications cabinets and enclosures.
  - 6. Outside Plant Grounding and Bonding
- B. Related Work Under Other Sections
  - 1. Related Sections:
    - a. Section 27 05 00 - Common Work Results for Communications
    - b. Section 27 05 29 - Hangers and Supports for Communications Systems
    - c. Section 27 05 33 - Conduits and Backboxes for Communications Systems
    - d. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures

**1.02 SYSTEM DESCRIPTION**

- A. Provide telecommunications system grounding conductor as described herein and indicate on drawings.
- B. Except as otherwise indicated, the complete communications installation including the metallic conduits and raceways, cable trays, boxes, cabinets, racks, panels, cable shields and lightning protectors shall be completely and effectively grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified.
- C. Resistance:
  - 1. Resistance from the farthest ground bus through the ground electrode to earth shall not exceed 5 Ohms or the requirements of ANSI-J-STD-607-B-2011, whichever is more restrictive.
  - 2. Resistance from Communications racks buss ground to Ufer ground must remain less than or equal to the electrical ground presented at A/C outlet for electronic equipment in the communications rack

**1.03 REFERENCES**

- A. American National Standards Institute (ANSI)
  - 1. ANSI-J-STD-607-B-2011 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
  - 2. ANSI/TIA/EIA-606-A-2002 Administration Standard for Commercial Telecommunications Infrastructure
- B. IEEE
  - 1. IEEE C135.30 (1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
- C. Underwriters Laboratories (UL)
  - 1. UL 467 (1993); R 2004 Grounding and Bonding Equipment

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### **1.04 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 Common Work Results for Communications.

### **PART 2 PRODUCTS**

#### **201 MANUFACTURERS**

- A. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:
  - 1. Ground Rod:
    - a. High strength high carbon steel, with electrolytically bonded jacket of copper on surface
    - b. 5/8" diameter minimum.
    - c. 5' long minimum.
    - d. UL spec. 467
    - e. ANSI C-33.8-1072.
    - f. Manufacturer:
      - 1) Allied Bolt
      - 2) Inwesco 12A60
      - 3) Blackburn
      - 4) Cooper Power Systems
      - 5) Weaver.
      - 6) Erico "Cadweld" Products, Inc.
      - 7) ITT Blackburn.
      - 8) Or equal.
  - 2. Ground Wells:
    - a. Christy Concrete Products, Inc.
    - b. Forni Corp.
    - c. Or equal.
  - 3. Ground Bushings, Connectors, Jumpers and Bus:
    - a. O-Z/Gedney.
    - b. Thomas & Betts Corp.
    - c. Or equal.
  - 4. Compression Connector Lug
    - a. Panduit
    - b. B-Line SB-479 Series
    - c. Thomas & Betts
    - d. Or equal.
  - 5. Telecommunications Ground Bus Bar
    - a. CPI Telecommunications Grounding BusBars
    - b. B-Line
    - c. Panduit
    - d. or equal.
  - 6. Rack and Cabinet Grounding
    - a. Middle Atlantic
    - b. Panduit Structured Ground Kit

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- c. Chatsworth Products Inc.
  - d. or equal.
- 7. Bonding Ribbon:
  - a. Annealed solid copper 3/8 inch wide x 1/16 inch thick, tin plated.
  - b. Manufacturer:
    - 1) Inwesco 12A55
    - 2) Corning Cable Systems
    - 3) Preformed Line Products.
    - 4) or equal.
- 8. Bonding Ribbon Clamp:
  - a. Soft lead
  - b. 1/16 inch thick
  - c. Bolt hole for attachment
  - d. Manufacturer:
    - 1) Inwesco 12A56
    - 2) Corning Cable Systems
    - 3) Preformed Line Products.
    - 4) Or equal.
- 9. Fargo Clamp:
  - a. Cast copper, silver plated, furnished with copper bolt.
  - b. RUS Listed
  - c. Manufacturer:
    - 1) Allied Bolt
    - 2) Inwesco 12A57
    - 3) Corning Cable Systems
    - 4) or equal.
- 10. Ground Inserts:
  - a. Cast Bronze with 1/4 copper Rod.
  - b. Provide minimum one each vault.
  - c. Provide minimum two each maintenance hole.
  - d. Manufacturer:
    - 1) Inwesco 12H69
    - 2) or equal by vault or manhole manufacturer.
    - 3) or equal.

## 202 GROUND CONDUCTORS

- A. General purpose insulated:
  - 1. NRTL listed and code sized copper conductor, with dual rated THHN/THWN insulation, color solid green. The jacket may have a yellow stripe.
  - 2. The jacket shall include markings that indicate conductor, manufacturer, and NRTL listing.
  - 3. Minimum wire size is #6 AWG UON. Grounding conductors larger than 4 AWG (5 mm) shall be stranded. Use solid conductors for 4 AWG (5 mm) and smaller.
  - 4. Use stranded grounding conductors at locations subject to vibration or repeated flexing, regardless of size.
  - 5. Where continuous color-coded conductors are not commercially available, provide a minimum 4 in. long color band with green, non-aging, plastic tape in accordance with NEC.

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The band shall be located within 152 mm (6 in.) of each termination and splice and at 1.2 m (4 ft.) intervals along its run.

6. Plenum rated, if run in plenum spaces.
- B. Telecommunications Bonding Backbone (TBB)
  1. A TBB shall be provided between the TMGB and each TGB.
  2. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 168 kcmil (No. 3/0 AWG; 12 mm).
- C. Bonding Conductor for Telecommunications (BCT)
  1. A BCT shall be provided between each TMGB and the building's service equipment (power) ground.
  2. The BCT shall be the same size as, or larger than, the largest TBB.
- D. Rack Bonding Conductor (RBC)
  1. A separate RBC shall be provided between each cabinet or rack and the TGB or TMGB in the room.
  2. Each RBC shall be sized as a 6 AWG (4 mm).
- E. Bonding Jumpers
  1. Bonding jumpers shall be used wherever two metallic parts meet in an electrically insecure connection. Examples include, without limitation, cable tray sections and cabinet or rack components and doors.
  2. Bonding jumpers shall be factory pre-terminated.
  3. Outside Plant Applications Grounding conductors shall be bare copper, meeting ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.
- F. Bonding pigtails: Insulated copper conductor, identified green, sized per code, and provided with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.

## **203 COMPRESSION CONNECTOR LUG**

- A. Description
  1. Connector lug with compression connection to conductor.
  2. Copper alloy body.
  3. Provide lug size to match conductor being terminated.
  4. Provide 2 hole pattern lugs.
  5. Provide each lug with silicon bronze hardware, including 2 bolts, 2 split lock washers and 2 nuts.

## **204 INSULATED GROUNDING BUSHINGS**

- A. Plated malleable iron or steel body with 150 degree Centigrade molded plastic insulating throat and lay-in grounding lug.

## **205 CONNECTIONS TO PIPE**

- A. For cable to pipe: UL listed bolted connection complying with CEC requirements.

## **206 CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES**

- A. Where required by the Drawings or Specifications, grounding conductors shall be spliced together, connected to ground rods or connected to structural steel using exothermic welds or high pressure compression type connectors.

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1. Exothermic welds shall be used for cable-to-cable and cable-to-ground rod and for cable to structural steel surfaces. Exothermic weld kits shall be as manufactured by Cadweld, Thermoweld or equal. Each particular type of weld shall use a kit unique to that type of weld.
2. High-pressure compression type connectors shall be used for cable-to-cable and cable-to-ground rod connections. Connections shall be as manufactured by Thomas & Betts #53000 series, Burndy "Hy-Ground" or equal.

### **207 EXTRA FLEXIBLE, FLAT BONDING JUMPERS**

- A. Where required by the drawing or specified herein.

## **PART 3 EXECUTION**

### **301 GENERAL**

- A. Provide Grounding and Bonding according to the most restrictive requirements of:
  1. ANSI-J-STD-607-B-2011.
  2. California Electrical Code Article 250 and references therein.
  3. California Electrical Code Article 800.
- B. In the event of conflicting requirements, California Electrical Code requirements shall prevail.

### **302 GENERAL**

- A. Provide Grounding and Bonding according to the most restrictive requirements of:
  1. ANSI-J-STD-607-B.
  2. California Electrical Code Article 250 and references therein.
  3. California Electrical Code Article 800.
- B. In the event of conflicting requirements, California Electrical Code requirements shall prevail.
- C. Point of Connection
  1. Under Work of this Section, make connections to Communications Ground Busbars provided under Work of Division 26, , as applies.
  2. Install busbars per manufacturer's instructions and at locations shown on the plans. If locations are unclear, apply for and conform to direction from the University's Representative.
- D. Routing
  1. Bonding conductors shall be continuous and routed in as direct a route as possible to the point of termination while adhering to the following: No bonding conductor shall vertically traverse a wall except at wall corners.
- E. Mechanical Connections
  1. Make connections bare metal to bare metal.
  2. At point of connection if device to be connected to does not provide dedicated unpainted grounding lug, remove paint to bare metal, make grounding or bonding connection, and apply touch up paint.
  3. Clean ground bars prior to terminating bonding conductors
  4. Torque threaded fasteners to manufacturer's recommended values.
- F. Compression Connections
  1. Make compression connections with the lug or fitting manufacturer's recommended tooling, with the tooling set to the recommended force and stroke.

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- G. Communications Raceways and Sleeves
  - 1. Bond metallic raceway and sleeves to the Communications Ground Busbar at the Communications Room that serves the related Communications Receptacle.
  - 2. Where a metallic raceway connects 2 or more Communications Rooms, bond to the Communications Ground Busbar at each.
- H. Cable Tray and Cable Runway
  - 1. Coordinate with the Work of Section 27 05 36 - Cable Trays for Communications Systems
  - 2. Provide manufacturer's bonding clips, plates or jumpers as required to comply with the UL Classified conditions for use as an equipment grounding conductor.
  - 3. Bond the Cable Runway to the Communications Ground Busbar at the Communications Room served.
- I. Cable Shields
  - 1. Comply with National Electrical Code Article 800.
- J. Protector Fields
  - 1. Comply with National Electrical Code Article 800.
- K. Communications cabinets and enclosures
  - 1. Bond each cabinet to the Communications Ground Busbar at the Telecommunications Room.
- L. Emergency/Information Telephone enclosures
  - 1. Bond as detailed on Communications Drawings.
- M. Communications Broadband Systems
  - 1. Comply with National Electrical Code Article 820.
  - 2. Ground Broadband passives as shown on Communications Drawings.

### 303 LABELING

- A. All labels shall be permanent, computer-generated and nonmetallic, printed with wording in high contrast to the background. Comply with Section 27 05 53 - Identification for Communications Systems.
- B. Each telecommunications bonding conductor shall be labeled as close as practicable to its point of termination in a readable position. Labels shall have:
  - 1. The statement, "If this connector or cable is loose or must be removed, please call the building telecommunications manager".
  - 2. An identification label providing the source and destination of the grounding conductor.
  - 3. Conductors contained completely within one room need not have the source and destination label.
  - 4. Instead, label the busbar at each connection with the name of bonded equipment (rack, tray, etc.) connected at that point.
- C. The BCT, or the conduit containing it, shall be labeled:
  - 1. At the TMGB with tag or adhesive label that states "Building Conductor for Telecommunications (BCT) to Main Electrical Service Ground Connection".
  - 2. At the main electrical service ground connection with tag or adhesive label that states "Building Conductor for Telecommunications (BCT) to Telecommunications Main Grounding Busbar (TMGB)".

### 304 TESTING

## Grounding And Bonding For Communications Systems - 270526

- A. All grounding connections shall be tested for continuity and resistance after installation but prior to substantial completion. The telecommunications contractor is to invite the District's Representative to witness a portion of this testing while it is being performed.
- B. The test performed shall use an earth ground resistance tester that is configured for a continuity test, otherwise known as a two-point test or a "dead earth" test. Tests shall be conducted between the electrical entrance ground and the TMGB as well as at each TGB. This resistance shall be less than 0.05 Ohms.

**3.05 GROUNDING AND BONDING OUTSIDE CABLE PLANT (OSP)**

- A. Underground Communications Structure Ground Rods
  - 1. Ground rods shall be installed at new communications handholes, vaults and pullboxes installed by the work of this Project. A ground rod shall be installed at new communications handholes, vaults, manholes and pullboxes installed by the work of this Project, or at existing underground structures used by the work of this Project lacking a ground rod.
    - a. Provide two ground rods at maintenance holes.
    - b. Elsewhere provide one ground rod.
  - 2. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.
  - 3. Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths.
    - a. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations.
    - b. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.
- B. Underground Cable Bonding
  - 1. Cables used in underground conduit systems have either an outer metallic sheath or a plastic sheath. Cables with an outer metallic sheath shall be bonded at each Maintenance Hole (MH). Cables with an outer plastic sheath shall be bonded at MHs where a splice is made. When using OSP cable for a LAN drop, splices should not be made.

**END OF SECTION**

## **SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS**

### **PART 1 GENERAL**

#### **1.01 SCOPE OF WORK**

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the provision of communications supports and cable hook system as described in this specification, including but not limited to:
  - 1. Strut supports
  - 2. Cable Hooks (J-hooks)
  - 3. Beam clamps
  - 4. Concrete Fasteners
  - 5. Touch-Up Materials
  - 6. Conduit supports.
  - 7. Equipment supports.
  - 8. Fastening hardware.
- B. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
  - 1. Section 27 05 00 - Common Work Results for Communications
  - 2. Section 27 05 26 - Grounding and Bonding for Communications Systems
  - 3. Section 27 05 33 - Conduits and Backboxes for Communications Systems
  - 4. Section 27 05 36 - Cable Trays for Communications Systems
  - 5. Section 27 05 39 - Surface Raceways for Communications Systems
  - 6. Section 27 05 48 - Noise and Vibration Controls for Communications Systems
  - 7. Section 27 05 53 - Identification for Communications Systems
  - 8. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
  - 9. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
  - 10. Section 27 11 23 - Communications Cable Management
  - 11. Section 27 13 00 - Communications Interior Backbone Cabling
  - 12. Section 27 14 00 - Communications Outside Plant Backbone Cabling
  - 13. Section 27 15 00 - Communications Horizontal Cabling

#### **1.02 SYSTEM DESCRIPTION**

- A. Provide devices specified in this Section and related Sections for support of communications equipment specified for this Project.
- B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

#### **1.03 REFERENCES**

- A. American Society For Testing and Materials (ASTM)
  - 1. ASTM A123/A123M-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - 2. ASTM A153/A153M-04 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - 3. ASTM B633-98e1 Specification for Electro-deposited Coatings of Zinc on Iron and Steel.

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4. ASTM A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. American National Standards Institute (ANSI)
  1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
  2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
  3. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
  4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, plus errata issued in October 2008.
  5. ANSI/ TIA 569-C (2012) Telecommunications Pathways and Spaces
- C. National Fire Protection Association
  1. NFPA 70, National Electrical Code

### 1.04 SUBMITTALS

- A. Conform with the requirements of Section 01 33 00 - Submittal Procedures and Section 27 05 00 - Common Work Results for Communications and the following:

### 1.05 QUALITY ASSURANCE

- A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.
- B. Cable hooks shall be listed and labeled by Underwriters Laboratories (UL) as required.
- C. Cable hooks shall have the manufacturers name and part number stamped in the part itself for identification.

## PART 2 PRODUCTS

### 201 SUPPORTING DEVICES

- A. General
  1. Supports to be sized to suit load and selected to match mounting conditions
- B. Manufacturers
  1. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:
    - a. Concrete fasteners:
      - 1) Phillips "Red-Head".
      - 2) Remington.
      - 3) Ramset.
      - 4) Hilti
      - 5) Simpson Strong-Tie
      - 6) or equal.
    - b. Concrete inserts and construction channel:
      - 1) Unistrut Corp.
      - 2) GS Metals "Globe Strut."
      - 3) Thomas & Betts "Kindorf" Corp.
      - 4) Or equal.
    - c. Conduit straps:

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- 1) O-Z/Gedney.
    - 2) Erico "Caddy" Fastening Products.
    - 3) Thomas & Betts "Kindorf" Corp.
    - 4) Or equal.
  - d. Beam Clamps
    - 1) Cooper B-Line
    - 2) SuperStrut
    - 3) Unistrut
    - 4) or equal
  - e. Aircraft Cable Sway Braces
    - 1) Mason Industries
    - 2) M.W. Sausse/Vibrex
    - 3) Loos & Company, Inc.
    - 4) or equal.
- C. Concrete Fasteners
  1. Furnish post-installed concrete anchors as required. Each post-installed anchor shall have an ICC-ES evaluation report stating that the product is compliant with the current edition of the CBC and the intended conditions of use.
  2. Provide expansion-shield type concrete anchors.
  3. Provide powder driven concrete fasteners with washers. Obtain approval from District's Representative prior to use.
- D. Concrete Inserts
  1. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of ¼ inch to ½ inch diameter thread for rod support.
- E. Aircraft cable sway braces
  1. Steel rope sized to meet load.
- F. Construction Channel:
  1. Construction:
    - a. 1-5/8" square galvanized channel formed from U.S.S.G No. 12 or 0.109 inch cold formed steel with 17/32-inch diameter bolt holes, and 1-1/2 inch on center in the base of the channel.
    - b. 10 foot sections.
  2. All supporting materials by same manufacturer.
- G. Beam Clamps
  1. Malleable iron electro-galvanized steel beam clamps selected to match building structural steel members.
- H. Conduit Straps
  1. One hole strap, steel or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
    - a. Use malleable strap with spacers for exterior and wet locations.
    - b. Use steel strap without spacers for interior locations.
  2. Steel channel conduit strap for support from construction channel.
  3. Steel conduit hanger for pendant support with threaded rod

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4. Steel wire conduit support strap for support from independent #12 gauge hanger wires.
- I. Threaded rods, couplings, screws and nuts:
  1. Electrolytically coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.
- J. Miscellaneous Parts
  1. Hot dipped galvanized after fabrication; after cutting, de-burring and hole drilling. Coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.
- K. Paint/Tape for Touch-up:
  1. Zinc: CRC "Zinc-It", Glyptal, Enterprise Galvanizing "Galambra", or equal.

### 202 CABLE HANGERS

- A. Ceiling Hung J-Hooks
  1. Drawing Reference(s):
    - a. WMJ
    - b. ACJ
  2. Features/Functions/Construction
    - a. Specifically intended to carry the load of up to 50 communications cables without applying excess forces to cables at bottom of bundle.
    - b. Integral broad bottom edge to spread cable load with flat bottom and provide a minimum of 1-5/8 inch cable bearing surface.
    - c. Integral hanger rod attachment hardware at top.
    - d. Load rated for application.
    - e. Incorporates smooth 90-degree radius edges to prevent snagging cable jackets on installation.
    - f. Designed so the mounting hardware is recessed to prevent cable damage.
    - g. Integral mechanical cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.
    - h. Suitable for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.
    - i. Multi-tiered cable hooks to be used where required to provide separate cabling compartments, or where additional capacity is needed.
    - j. Finishes:
      - 1) Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
      - 2) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.
  3. Manufacturer
    - a. Cooper B-Line series BCH21, BCH32, BCH64
    - b. Caddy/Erico CableCat
    - c. or equal.

### PART 3 EXECUTION

#### 301 GENERAL

- A. The District's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at

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no additional cost to the District.

### **3.02 EXAMINATION**

- A. Thoroughly examine site conditions for acceptance of supporting device installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

### **3.03 PREPARATION**

- A. Coordinate size, shape and location of concrete pads required for equipment installation with Division 3, Cast-in-place Concrete Specification.
- B. Layout support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.
- C. Where shown on the Drawings or Specifications, install freestanding communications equipment on concrete pads.

### **3.04 INSTALLATION**

- A. Furnish and install supporting devices as noted throughout Division 27.
- B. Communications device and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.
- C. Fasten hanger rods, conduit clamps, outlet and junction boxes to building structure using precast inserts, expansion anchors, preset inserts or beam clamps.
- D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls.
- E. Use expansion anchors or preset inserts in solid masonry walls.
- F. Use self-drilling anchors, expansion anchor, or preset inserts on concrete surfaces.
- G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
- H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
- I. Do not drill structural steel members unless first approved in writing by the District's Representative.
- J. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- K. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.
- L. Bridge studs top and bottom with channels to support flush mounted cabinets and panelboards in stud walls.

### **3.05 ERECTION OF METAL SUPPORTS**

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

### **3.06 WOOD SUPPORTS**

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in

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location, alignment, and elevation to support and anchor electrical materials and equipment.

**3.07 ANCHORAGE**

- A. Conform with the means of anchorage described in the DSA approved Contract Documents

**3.08 DISTRIBUTION PATHWAY VIA CEILING HUNG CABLE HOOKS (J-HOOKS):**

- A. Void, Plenum or Suspended Ceiling Exposed Cable Installation. Where drawings specifically show or permit use of exposed cable installation in voids, conform to the most restrictive requirements of Code, TIA-569-C and this Section.
- B. Provide support for all cabling. Do not place or attach directly to T-bar grid, concealed spline grid, flexible or rigid ductwork, HVAC registers, sprinkler piping or fixtures, light fixtures or building structure. Conform to the National Electric Code.
- C. Placement:
1. All pathways created by ceiling hung cable hooks shall be reviewed by the District's Representative prior to installation.
  2. Ceiling hung cable hooks and cabling supported by same shall not obscure access to access doors, hatches, air dampers, valves, filter sections, VAV boxes, cable trays, junction boxes, pull boxes or similar areas of access required by other trades.
  3. All ceiling hung cable hooks shall be mounted close enough together such that upon completion of the station cable installation a minimum amount of cable droop occurs between adjacent rings. The distance between supporting rings shall not exceed 48 inches or as required by the current edition of TIA-569-C.
- D. Refer to the separation requirements listed in Section 27 15 00 - Communications Horizontal Cabling for minimum distances from electrical power and other electromagnetic sources.
- E. Follow manufacturer's recommendations for allowable fill capacity for each size of cable hook.
1. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
  2. Spring steel cable hooks shall be capable of supporting a minimum of 100 pounds with a safety factor of 3 where extra strength is required.
  3. Where aggregate cable bundle supported by ceiling hung cable hooks exceeds either the rated cable or weight load limit of the ceiling hung cable hook system, provide ceiling basket tray - Type CTW - as specified in Section 27 05 36.

**END OF SECTION**

## SECTION 270533 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK:

- A. Provide telecommunications pathways in accordance with ANSI/TIA-569-C, as specified in this Section and as shown on the plans. Provide system furniture pathways in accordance with UL 1286.
  - 1. Provision of all low voltage Communications Systems Pathway, including:
    - a. Rigid steel conduit and fittings.
    - b. PVC insulated rigid steel conduit and fittings.
    - c. Intermediate metal conduit and fittings.
    - d. Electrical metallic tubing and fittings.
    - e. Flexible metallic conduit and fittings.
    - f. Liquidtight flexible metallic conduit and fittings.
    - g. Miscellaneous conduit fittings and products.
  - 2. Terminal cabinets and pull boxes
  - 3. Device Boxes
  - 4. TelePower Poles
  - 5. Wireless Access Point Enclosures
- B. Provide fire penetration sealant systems at rated wall and floor/ceiling penetrations and where indicated.
- C. At Hazardous Occupancies, installation conforms to the requirements of National Electric Code for Class and Division rating of spaces.

#### 1.02 RELATED WORK IN OTHER SECTIONS:

- A. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
  - 1. Division 1: Cutting and patching.
  - 2. Section 27 05 00 - Common Work Results for Communications.
  - 3. Section 27 05 26 - Grounding and Bonding for Communications Systems
  - 4. Section 27 05 29 - Hangers and Supports for Communications Systems
  - 5. Section 27 05 33 - Conduits and Backboxes for Communications Systems
  - 6. Section 27 05 36 - Cable Trays for Communications Systems
  - 7. Section 27 05 39 - Surface Raceways for Communications Systems
  - 8. Section 27 05 48 - Noise and Vibration for Communications Systems
  - 9. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
  - 10. Section 27 13 00 - Communications Interior Backbone Cabling
  - 11. Section 27 14 00 - Communications Outside Plant Backbone Cabling
  - 12. Section 27 15 00 - Communications Horizontal Cabling

#### 1.03 REFERENCES

- A. Usage: In accordance with Division 1.
  - 1. American National Standards Institute (ANSI)
    - a. ANSI C80.1 1994 Rigid Steel Conduit - Zinc Coated

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- b. ANSI C80.3 1991 Electrical Metallic Tubing - Zinc Coated
- 2. American Society For Testing and Materials (ASTM)
  - a. ASTM E 84 Surface Burning Characteristics of Building Materials
  - b. ASTM E 119 Fire Tests of Building Construction and Materials
  - c. ASTM E 814 Fire Tests of Penetration Firestop Systems
- 3. BICSI
  - a. Telecommunications Distribution Methods Manual (TDMM)
  - b. Information Transport Systems Installation Methods Manual (ITSIMM)
- 4. National Electrical Manufacturers Association (NEMA)
  - a. NEMA 250-2003 Enclosures for Electrical Equipment (1000 Volts Maximum)
  - b. NEMA FB 1 (ANSI/NEMA FB 1-2003) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
  - c. FB 2.10 2000 Selection and Installation Guidelines For Fittings For Use With Non-Flexible Metallic Conduit Or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, And Electrical Metallic Tubing).
  - d. FB 2.20 2000 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
  - e. NEMA ICS 6 1988 (Rev. 1) Enclosures for Industrial Control and Systems
  - f. NEMA OS 3-2002 Selection and Installation Guidelines for Electrical Outlet Boxes.
  - g. NEMA RN 1-1998 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
  - h. NEMA TC 7 2000 Smooth Wall Coilable Polyethylene Electrical Plastic Duct
  - i. NEMA TC 13 2000 Electrical Nonmetallic Tubing (ENT).
  - j. NEMA TC 14 1984(R 1986) Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings
- 5. National Fire Protection Association
  - a. NFPA 101 Life Safety Code
- 6. Underwriters Laboratories, Inc. (UL)
  - a. UL 1 2000 Flexible Metal Conduit
  - b. UL 6 2004 Electrical Rigid Metal Conduit - Steel
  - c. UL 50 (1995; R 1999, Bul. 2001) Enclosures for Electrical Equipment
  - d. UL 263 Fire Tests of Building Construction and Materials
  - e. UL 360 1986 (Bul. 1991) (R 1993) Liquid-Tight Flexible Steel Conduit
  - f. UL 514A 1991 (R 2004) Metallic Outlet Boxes
  - g. UL 514B 1989 (R 2004) Conduit, Tubing and Cable Fittings
  - h. UL 514C 1996 (R 2000) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
  - i. UL 651 1989 (R 1989) (Bul. 1993) Schedule 40 and 80 Rigid PVC Conduit.
  - j. UL 723 Surface Burning Characteristics of Building Materials
  - k. UL 797 1993 (R 2004) Electrical Metallic Tubing - Steel
  - l. UL 1242 1983 (R1993) (Bul. 1993) Intermediate Metal Conduit.
  - m. UL 1286 (1999; R 2001, Bul. 2002) Office Furnishings
  - n. UL 1479 Fire Tests of Through Penetration Firestops
  - o. UL Fire Resistance Directories

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#### **1.04 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications and the following:
  - 1. Contractor shall complete and submit for review to District's Representative, a Coring/Sawcutting Summary Description and obtain written authorization for District prior to the commencement of any cutting or coring activities. Contractor shall include all pertinent information with the Coring/Sawcutting Summary Description and submit with detailed work plan fourteen (14) days prior to desired coring/cutting activity.
    - a. Coring/Saw-cutting Summary Description to identify means of protection of:
      - 1) Structural integrity of any element of Project.
      - 2) Integrity of weather-exposed or moisture-resistant element.
      - 3) Efficiency, maintenance, or safety of any operational element.
      - 4) Visual qualities of sight-exposed elements.
      - 5) Work of District.
      - 6) Utility supply, drains, fire alarm, communication.
    - b. Include in request:
      - 1) Identification of Project, including District's Project Name and A/C number. Location and description of affected Work.
      - 2) Necessity for cutting and patching.
      - 3) Description of proposed work, and products to be used, methods to be employed to locate existing structural members.
      - 4) Alternatives to cutting and patching.
      - 5) Effect on work of District.
      - 6) Date and time work will be executed.
      - 7) Location on form for District's Representative to provide direction.

#### **1.05 QUALITY ASSURANCE**

- A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.
- B. Only products and applications listed in this Section may be used on the project unless otherwise submitted and approved by the District's Representative.
- C. Comply with Section 27 00 00 Communications General Requirements.
- D. Firestopping installations shall use only complete systems purchased as a whole unit. Firestopping using individual material components or parts/materials collected from multiple kits is prohibited.
- E. The firestopping systems used shall be tested and qualified for the purpose by an independent Nationally Recognized Testing Laboratory. Mortar, grout and similar substances shall not be used to seal telecommunications openings in a fire-rated wall, ceiling or floor.
- F. Mortar may be used to fill the annular space around a sleeve only if such material and application meets the requirements of the California Building Code Section 713, paragraph 713.3.1.
- G. Firestopping products shall bear the classification marking of the qualified testing and inspection agency.
- H. Installation shall be by qualified and trained technicians. The Contractor shall, at their

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expense, replace entirely any firestop system installed by an uncertified installer. Minimum installer qualifications are as follows:

1. FM Research approved in accordance with FM AS 4991.
  2. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training and a minimum of 1 year experience in the installation of the manufacturer's products per specified requirements.
- I. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the Installer. The Installer shall have been trained by a direct representative of the manufacturer (not a distributor or sales agent) in the proper selection and installation procedures.

### PART 2 PRODUCTS

#### 201 GENERAL

- A. Provide the following types of conduit systems listed by their commonly used generic name.

#### 202 RACEWAY

- A. Manufacturers:
1. Raceway:
    - a. Allied Tube and Conduit Co.
    - b. Triangle PWC, Inc.
    - c. Western Tube and Conduit Corp.
    - d. Spring City Electrical Manufacturing Co.
    - e. Occidental Coating Co. (OCAL).
    - f. Alflec Corp.
    - g. American Flexible Metal Conduit Co.
    - h. Anaconda.
    - i. Or equal.
  2. Fittings:
    - a. Appleton Electric Co.
    - b. OZ/Gedney.
    - c. Thomas & Betts Corp.
    - d. Spring City Electrical Manufacturing Co.
    - e. Occidental Coating Co. (OCAL).
    - f. Carlon.
    - g. or equal.
- B. Rigid Steel Conduit.
1. Drawing and Spec Reference: RSC.
  2. Construction:
    - a. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and UL 6.
    - b. Standard threaded couplings, locknuts, bushings, and elbows: Only materials of steel or malleable iron are acceptable. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure.
    - c. Three piece couplings: Electroplated, cast malleable iron.
    - d. Insulating bushings: Threaded polypropylene or thermosetting phenolic rated

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- 150 degree C minimum.
  - e. Insulated grounding bushings: Threaded cast malleable iron body with insulated throat and steel "lay-in" ground lug with compression screw.
  - f. Insulated metallic bushings: Threaded cast malleable iron body with plastic insulated throat rated 150 degrees C.
  - g. All fittings and connectors shall be threaded.
- C. Coated Rigid Steel Conduit:
- 1. Drawing and Spec Reference: CRSC.
  - 2. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.
  - 3. Fittings:
    - a. Conduit couplings and connectors shall be as specified for galvanized rigid steel conduit and shall be factory PVC coated with an insulating jacket equivalent to that of the coated material.
    - b. Fittings over-sleeve to extend 1 conduit diameter or 1-1/2" beyond fitting, whichever is less.
  - 4. Performance:
    - a. Tensile Strength: 3500 psi.
  - 5. Approvals:
    - a. NEMA RN1 (Type 40 - 40 mils thick)
    - b. CalTrans Type 2
  - 6. Manufacturers:
    - a. Plastibond by RobRoy Industries.
    - b. Occal-40 by Occidental Coating Company.
    - c. KorKap by Plastic Applicators.
    - d. Ocal-Blue
    - e. or equal.
- D. Intermediate Metal Conduit
- 1. Drawing Reference: IMC
  - 2. Conduit: Hot dip galvanized steel meeting the requirements of NEC Article 345 and conforming to ANSI C80.6 and UL 1242.
  - 3. Fittings: Conduit couplings, connector and bushing shall be as specified for galvanized rigid steel conduit. Integral retractable type IMC couplings are also acceptable.
- E. Electrical Metallic Tubing.
- 1. Drawing and Spec Reference: EMT.
  - 2. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 specifications and shall meet UL classifications.
  - 3. Set screw type couplings: Electroplated, steel or cast malleable iron, UL listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2 inches. Setscrews shall be of case hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
  - 4. Set screw type connectors: Electroplated steel or cast malleable iron UL listed concrete tight with male hub and insulated plastic throat, 150 degree C temperature rated.

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Setscrew shall be same as for couplings.

5. Raintight couplings: Electroplate steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
6. Raintight connectors: Electroplated steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.

### F. Flexible Conduit:

1. Drawing Reference: FLEX
2. Construction:
  - a. Flexible steel, zinc coated on both inside and outside by hot-dipping process.
  - b. Interlocking spirally wound continuous steel strip.
  - c. 3/4" minimum size.
3. Fittings: Connectors shall be of the single screw clamp variety with steel or cast malleable iron bodies and threaded male hubs with insulated throats. Exception: Pressure cast screw-in connectors shall be acceptable for fixture connection in suspended ceilings and cut-in outlet boxes within existing furred walls.
4. Approvals:
  - a. UL 1

### G. Liquidtight Flexible Metallic Conduit

1. Drawing Reference: Liquidtight
2. Conduit: Shall be fabricated in continuous lengths from galvanized steel strips, interlocking spirally wound, covered with extruded liquidtight jacket of polyvinyl chloride (PVC) and conforming to UL 360. Provide conduit with a continuous copper-bonding conductor wound spirally between the convolutions.
3. Fittings: Connector body and gland nut shall be of cadmium plated steel or cast malleable iron, with tapered, male, threaded hub; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland shall be of molded nylon with an integral brass push-in ferrule.

## 203 MISCELLANEOUS CONDUIT FITTINGS AND PRODUCTS

### A. General

1. UL 514B.
2. Listed in UL Electrical Construction Materials List.

### B. Conduit Fittings, Insulated Throat Grounding Bushings

1. Description
  - a. Threaded for Rigid Steel Conduit and Intermediate Metal Conduit.
  - b. UL Listed for use with copper conductors.
  - c. Thermoplastic insulated liner for 105 degrees Celsius.
  - d. Body of malleable iron, zinc plated; or die cast zinc.
2. Manufacturer
  - a. Thomas & Betts (Steel City) BG-801 Series
  - b. O-Z/Gedney
  - c. or equal.

- C. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC

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sleeve.

- D. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.
- E. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.
- F. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate .75-inch deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless steel jacket clamps. Unit shall comply with UL467 and UL514.
  - 1. Manufacturer:
    - a. OZ/Gedney Type DX
    - b. Steel City Type EDF
    - c. or equal.
- G. Standard products not herein specified:
  - 1. Submit for review a listing of standard electrical conduit hardware and fittings not herein specified prior to use or installation, i.e. locknuts, bushings, etc.
  - 2. Listing shall include manufacturers name, part numbers, and a written description of the item indicating type of material and construction.
  - 3. Miscellaneous components shall be equal in quality, material, and construction to similar items herein specified.
- H. Hazardous area fittings: UL listed for the application.

### **204 BOXES AND ENCLOSURES**

- A. Junction and Device Boxes
  - 1. Drawing References: As shown on Symbol Schedule
  - 2. Construction:
    - a. General
    - b. One or two piece welded knockout boxes.
      - 1) Interior
        - (a) UL 514A, cadmium or zinc-coated 1.25 oz/sq. ft., if ferrous metal.
        - (b) UL 514C approved if non-metallic.
      - 2) Exterior - Conform to the Junction and/or PullBox construction scheduled on the Plans. Where construction not otherwise scheduled or noted on the plans, conform to the following
        - (a) Cast iron or aluminum with threaded hubs and mounting lugs.
        - (b) Gasketed cover with spring lid.
    - c. If size not otherwise noted, at least 4-11/16" Square by 2-1/8" deep, or Code minimum size, whichever is larger. Where Category 6A devices are terminated, minimum size to be 5" square (5S) by 3" deep.
    - d. Provide complete with approved type of connectors and required accessories, including attachment lugs or hangers. Provide raised device covers as required

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- to accept scheduled device.
- e. Concealed/Flush Mounted
  - 1) Provide Flush Mount Device Boxes unless otherwise indicated.
  - 2) At gypsum wall assemblies, hollow masonry, tile walls and plaster walls, provide with device rings as required.
- f. Surface Mounted
  - 1) Match Backbox to Device plate such that no sharp edges or voids remain exposed to the public.
- g. Concrete floor embedded:
  - 1) Cast iron concrete pour boxes with screwed brass cover, unless otherwise noted.
  - 2) Cadmium plated screw cover attachment at least 6" on center.
- 3. Approvals.
  - a. UL 514A
  - b. UL 514C, if non-metallic
- 4. Manufacturers:
  - a. Interior:
    - 1) Steel City.
    - 2) Randl
    - 3) Bowers
    - 4) Thomas and Betts
    - 5) or equal.
  - b. Exterior, exposed with cover of same construction.
    - 1) Appleton
    - 2) Pyle-National
    - 3) or equal.
  - c. Other conditions:
    - 1) Any meeting approvals and requirements.

### **205 TERMINAL BOXES, PULL CANS AND ENCLOSURES**

- A. Terminal Cabinets:
  - 1. Drawing Reference: As Scheduled.
  - 2. Construction:
    - a. General
      - 1) Interior dimensions not less than those scheduled.
      - 2) Door face to be not less than 95% of panel interior dimensions.
      - 3) Provide with 3/4" fire retardant treated ply backboard where device termination scheduled/required within enclosure
    - b. Interior Application
    - c. Zinc Coated Sheet Steel, code gauge with standard concentric knockouts for conduit terminations.
    - d. Finish: Manufacturer's standard gray baked enamel finish.
    - e. Flush mounted enclosure Covers: Trim fitted, continuous hinged steel door, flush catch - lockable and keyed to match. Screw fastened doors not acceptable.
    - f. Surface mount cabinets shall be furnished with screw cover trim, flush hinged door and shall not be less than 6 inches deep.

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- g. Exterior Applications
    - 1) Door and lock arrangement as required by manufacturer to maintain specified rating.
- 3. Mounting:
  - a. Flush mount cabinets shall be furnished with concealed trim clamps and shall be not less than 4 inches deep or as scheduled, whichever is greater
- 4. Approvals
  - a. Interior Applications:
    - 1) NEMA 250 Type 1, unless otherwise noted. Refer to plans and schedules.
  - b. Exterior Applications:
    - 1) NEMA 250 Type - As scheduled, not less than NEMA 3R. Provide NEMA 4 and 4X where scheduled or where required to match installation conditions.
- 5. Manufacturers, Metallic Enclosures:
  - a. B-Line Electrical Enclosures
  - b. Circle AW Products.
  - c. Hammond
  - d. Hennessey.
  - e. Hoffman.
  - f. Myers Electric Products
  - g. Rittal.
  - h. or equal.
- 6. Manufacturers, Non-metallic Enclosures
  - a. Stahlin Enclosures
  - b. Cabletek
  - c. RMS Electronics, Inc
  - d. STI, Inc
  - e. Vynckier Inc.
  - f. Or equal.

### 206 TELEPOWER POLES

- A. Telepower Poles, Multiservice
  - 1. Drawing Reference(s):
    - a. Power Pole
    - b. Telepower Pole
    - c. Communications Pole
  - 2. Minimum Features, Functions, Construction:
    - a. Frame
      - 1) The frame shall be mill finished 6063-T6 aluminum with snap on steel and/or aluminum covers and satin anodized aluminum end caps. Covers and access panels may also be painted over and are suitable for field painting.
      - 2) The frame shall be a four-piece design with two center supports and snap-on covers and end caps, yielding a total of three useable wire and cable channels. The product will be available in two sizes -- small and large. Total small width shall be 8.9" by 3.8" deep. The large size will be 13.4" wide by 3.8" deep. The aluminum extrusions will be a minimum thickness of 0.06", and steel covers

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- .040" . The system shall be available in 10' 6" height. The system shall be available with an extension kit that includes aluminum tubes to allow for varying ceiling heights up to 15'. Access panels and covers up to a height of 30" above finished floor will provide access to wiring and devices.
- 3) The frame supports shall be available with factory pre-punched holecuts for communication receptacles and trade knockouts for electrical terminations.
- b. Center Panels
    - 1) The center panel shall be constructed of painted steel, aluminum or stainless steel in 96", 30", 24", and 6" heights. A large assortment of center panel adornments shall be available. These finishes shall include wood laminate, metal laminate, nonmetallic laminate, fabric, and a painted surface. Perforated metal in painted steel and glass panels shall be available for the upper sections. An open center option is also offered. This option consists of a metallic panel from the floor to 30" high. The remainder of the center section is open to the ceiling.
  - c. Fittings
    - 1) A full compliment of fittings must be available including, but not limited to, internal braces with knockouts, snap-in dividers and wire clips, ceiling and carpet trim pieces. The fittings shall be manufactured of extruded aluminum, galvanized steel, and/or plastic.
    - 2) The assembly manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP, STP, Fiber Optic, Coaxial and other cabling types with faceplates and bezels to facilitate mounting.
3. Manufacturer:
    - a. Wiremold Vista, with Center Panel finishes as selected by the District's Representative.
    - b. Hubbell
    - c. Or equal

## **207 WIRELESS ACCESS POINT ENCLOSURES**

- A. Wireless Access Point (WAP) Enclosure, Exterior Application
  1. Drawing Reference: WAP - where shown at exterior of building and/or described as same in keynotes/schedules.
  2. Features/Functions/Construction:
    - a. Compact, low profile wireless access point enclosure suitable for use in continuous outdoor exposure under weather conditions typical of the project site.
    - b. Designed to NEMA 1, 2, 4, 4X, 12, and 13, and IEC529-IP66 specifications for indoor/ outdoor wet, dirty, or corrosive environments.
    - c. UV stabilized for exposure to direct sunlight
    - d. Effectively transparent to wireless signals in the frequency bands used by IEEE 802.11a, b, g, n and ac signaling
    - e. Included universal mounting plate allows easy installation of most manufacturers access points
    - f. Solid opaque cover is hinged and can be latched and locked with District furnished padlock.
    - g. UL508 listed. Back box and cover are light gray UL94-5VA Polycarbonate/PBT

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- blend. Field paintable to match surrounding surfaces.
- h. Nominal dimensions: 15.7" x 11.7" x 4.8" deep.
- 3. Manufacturer:
  - a. Oberon 1024-00 PBT/Polycarbonate NEMA 4 enclosure for WAP, with hinged, solid door.
  - b. Or equal (no known equal).

## **208 THROUGH PENETRATION SEALING SYSTEMS**

- A. Through Penetration Sealant Assembly, Re-Enterable (Zero Maintenance)
  - 1. Drawing Reference: TPSR and as required at all new through penetrations through rated partitions.
  - 2. Application
    - a. Provide at all locations where open wire communications cabling penetrates fire-rated assemblies in basket tray, cable tray or supported by J-hooks. Zero-maintenance firestop assemblies shall be used when the pathway on one or both sides of the wall, ceiling or floor is open, such as J-hooks or cable tray.
    - b. Communications conduit sleeves through a single fire-rated wall shall not be used. For these applications, a zero-maintenance firestop assembly is required.
  - 3. Functions
    - a. Cables passing through fire-rated floors or walls shall pass through fire-rated assemblies which can be used by the District's technical staff to add and remove cabling without having to apply or remove putty fill, backing or similar compounds to maintain the necessary fire rating.
    - b. Through penetration system to feature either automatic self adjustment mechanisms, or integral mechanical adjustment mechanisms to permit the District's staff to adapt the assembly to the fill condition without need for supplementary or disposable materials. The assembly shall contain 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.
    - c. Assemblies shall have an F Rating and T Rating equal to the rating of the barrier in which the device is installed, where such performance is required by Code.
    - d. 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 the cabling cross-sectional area enough spare capacity to accommodate 50% growth. Upon commissioning, if adequate spare capacity is not observed, the contractor shall install additional assemblies at their own cost to provide such spare capacity
  - 4. Approvals:
    - a. California State Fire Marshal.
    - b. Tested to UL 1479
    - c. UL 2043
  - 5. Manufacturers - Select for application:
    - a. Specified Technologies Inc. EZ-Path Fire Rated Pathway

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- b. Wiremold FlameStopper
  - c. Hilti CP 653 Speedsleeve
  - d. or equal.
- B. Firestopping for Conduits and Other Closed Pathways
  - 1. Approvals: California State Fire Marshal
  - 2. Tested to UL 1479 or ASTM E814.
  - 3. Manufacturers:
    - a. Specified Technologies, Inc.
    - b. 3M
    - c. or equal.

### **209 SAW-CUTTING AND CORE-DRILLING EQUIPMENT AND MATERIALS**

- A. Cutting Equipment, Tools, and Materials
  - 1. Contractor shall furnish appropriate and proper equipment, tools, and materials for the saw-cutting and core-drilling of concrete as required.
  - 2. Lubricant material for the cutting of concrete shall be of type and manufacture for the purpose.
- B. Concrete Bonding Agent: Adhesive for the bonding of new mortar and grout to existing concrete shall be "Concresive LPL" as manufactured by Master Builders, Burke's "BurkEpoxy MV", Sika's "Sikadur 32, Hi-Mod", or equal.
- C. Patching Mortar
  - 1. Mortar: Mortar shall be an epoxy mortar or similar high bonding mortar, such as "SikaTop 122" as manufactured by Sika Corporation, Burke, "Masterpatch 20" as manufactured by Master Builders, or equal.
- D. Sand:
  - 1. Sand shall be a washed, kiln-dried fine sand, all passing a U.S. Standard No. 16 sieve.
- E. Curing Compound:
  - 1. Water-based curing compound such as Master Builders "Masterkure", Burke's "Spartan-Cote", or approved equal.

### **210 EXTERIOR JOINT SEALANTS**

- A. Exterior Polyurethane Weatherproofing and Control Joint Sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT, M, G, A, and O; single component, chemical curing, non-staining, non-bleeding, non-sagging type; color as selected; use in exterior vertical surfaces such as, but not limited to:
  - 1. Sealing around exterior wall penetrations required for conduit pathways.
  - 2. Manufacturers:
    - a. Pecora Corporation; Dynatrol I.
    - b. Sika Corporation, Inc.; Sikaflex 1a.
    - c. BASF (Sonneborne); NP 1.
    - d. Tremco; Dymonic FC.
- B. Joint Sealant Backing
  - 1. General: Provide sealant backings and accessory materials, including primers, of material and type that are non-staining; are compatible with joint substrates, sealants, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

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2. Foam Joint Fillers: Non-gassing, preformed, compressible, resilient, non-staining, non-waxing, non-extruding strips of flexible plastic foam of one of materials indicated below, as recommended by manufacturer for compatibility with their sealant; of size, shape, and density to control sealant depth, prevent three-sided adhesion, provide a surface against which to tool, and otherwise contribute to producing optimum sealant performance:
  - a. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance and as recommended by sealant manufacturer.
  - b. Elastomeric Tubing Sealant Backings: Flexible cellular rubber tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
  - c. Filler Type at EIFS Conditions: Non-gassing, closed-cell polyethylene foam as recommended by EIFS manufacturer.
- C. Miscellaneous Sealant Materials
  1. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealant-substrate tests and field tests. Certify that primer will not permanently stain adjacent joint surfaces.
  2. 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 in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.
  3. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints, to mask off adjacent joint surfaces where sealant is not permanently intended to be applied.
  4. Bondbreaker Tape: Polyethylene pressure sensitive adhesive tape, to be used in areas where backer rod cannot fit and where three-sided adhesion is to be avoided.

## **PART 3 EXECUTION**

### **3.01 CONDUIT APPLICATION**

- A. General: Install the following types of conduits and fittings in the locations listed, unless otherwise noted in the drawings:
  1. Exterior, Exposed:
    - a. Type RSC or IMC.
  2. Interior, Exposed, Wet and Damp Locations:
    - a. Type RSC.
    - b. At interior locations over 8 feet above finished floor, EMT with compression fittings acceptable.
  3. Interior, Hazardous Locations

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- a. Type RSC
  - b. Type IMC, where permitted by the CEC.
4. Interior, exposed or concealed, dry locations:
  - a. RSC or IMC, if exposed or subject to physical abuse.
  - b. EMT, if fully concealed.
5. Interior, concealed, damp locations, including in masonry walls.
  - a. RSC or IMC
6. Embedded in Concrete
  - a. RSC or rigid non-metallic conduit.
  - b. PVC Schedule 40 or Type DB-120.
7. Transition from walls to open plan furniture systems:
  - a. Liquidtight

### 3.02 GENERAL REQUIREMENTS

- A. Refer to the manufacturer's instructions and conform thereto.
- B. Distribution Pathway via EMT Raceway:
  1. The EMT conduit is to be installed meeting the NEC handbook Article 348 Installation Specifications.
  2. Provide escutcheon plates for all through wall conduit stubs.
  3. All ends of conduits shall be cut square, reamed and fitted with insulated bushing.
  4. All conduit which passes through fire walls shall be sealed with fire stop putty after all station wire has been installed.

### 3.03 MOUNTING AND INSTALLATION - BOXES AND ENCLOSURES

- A. Conform to the more restrictive of NEMA OS 3-2002 and the following.
- B. Provide backboxes at all communications systems devices. Installation of device plates directly to wall surface without use of a backbox, unless specifically directed on plans, is unacceptable.
- C. The distance between pull boxes shall not exceed 150 feet or more than two 90 degree bends.
- D. Align boxes plumb with floor and surrounding construction. At door frames, locate 4" from frame. Verify placement with District's Representative details to ensure that box clears all trim, etc.
- E. Support and fasten boxes securely. At stud walls use rigid bar hangers, attached to hanger with stud and nut.
- F. At existing locations, provide cutting, patching and finishing as required to maintain or restore finishes so that resulting installation is integrated into the Architectural decor of the particular location.
- G. Mounting Height: the mounting height of a wall-mounted outlet box is defined as the height from the finished floor to the horizontal center line of the cover plate.
- H. Mount outlet boxes with the long axis vertical. Three or more gang boxes shall be mounted with the long axis horizontal.
- I. Install wiring jacks and outlet devices only in boxes which are clean; free from excess building materials, dirt, and debris.
- J. Install wiring jacks and outlet devices after wiring work is complete.

### 3.04 SUPPORT

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- A. Provide supports for raceways as specified in Section 27 05 29 - Hangers and Supports for Communications Systems.
- B. All raceways installed in exposed dry locations shall be grouped in a like arrangement and supported by means of conduit straps, wall brackets or trapeze hangers in accordance with Code and the requirements of the this Section. Fasten all hangers from the building structural system.
- C. Provide supports and mounting attachments per the most restrictive of Code and the following.

RACEWAY SIZE (INCHES)	NO OF CABLES IN RUN	LOCATION	SUPPORT SPACING (FEET)	
			RSC	EMT
<b>HORIZONTAL RUNS</b>				
1/2, 3/4	1-2	FLAT CEILING WALL RUNS	5	5
1/2, 3/4	1-2	WHERE ACCESS LIMITED TO BUILDING STRUCTURE	7	7
1/2, 3/4	3≥	ANY LOCATION	7	7
1≥	1-2	FLAT CEILING OR WALL	6	6
1≥	1-2	WHERE ACCESS LIMITED TO BUILDING STRUCTURE	10	10
1≥	3≥	ANY LOCATIONS	10	10
ANY	ANY	CONCEALED	10	10
<b>VERTICAL RUNS</b>				
1/2, 3/4	ANY	EXPOSED	7	7
1, 1-1/4	ANY	EXPOSED	8	8
1-1/2≥	ANY	EXPOSED	10	10

- A. Install no more than one coupling or device between supports.
- B. Conduit support
  - 1. As specified in Section 27 05 29 - Hangers and Supports for Communications Systems

### **3.05 CUTTING AND PENETRATIONS**

- A. Execute all cutting, associated structural reinforcing, and patching/restoring work in a manner to prevent damage to other work and to provide proper surfaces for the installation of materials, equipment, and repairs.
- B. Perform demolition in accordance with ANSI A10.6 "Safety Requirements for Demolition Operations" and NFPA 241 "Standard for Safeguarding Construction, Alteration, and Demolition Operations", applicable regulatory requirements of public authorities having jurisdiction, the requirements of Division 1 and this specification section.
- C. Do not cut or alter structural members when not indicated without prior approval of the District's Representative.
- D. Execute cutting and patching of weather-exposed, moisture-resistant and sight-exposed surfaces by methods to preserve weather, moisture and visual integrity. Employ skilled

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workers for cutting and patching. Wherever practicable, employ original installer or fabricator providing Work under this Contract to perform cutting and patching for new work.

- E. Provide temporary support of construction to be cut to ensure structural integrity.
- F. Perform cutting and patching using methods and materials so as not to void existing warranties.
- G. Cutting:
  - 1. Cut existing construction to provide for installation of Work. Make new openings neat, as close as possible to profiles indicated and only to extent necessary for new Work.
  - 2. Do not cut or alter structural members without prior consultation with the District's Representative. Do not damage reinforcing or structural steel to remain. Do not damage electrical conduits, plumbing lines, and other utilities to remain. Restore any damaged work at Contractor's expense.
  - 3. At concrete, masonry, paving, and other materials where edges of cuts and holes will remain exposed in the completed Work, make cuts using power-sawing and -coring equipment; do not overcut at corners of cut openings. Saw overruns shall not be permitted. Refer to additional concrete coring specific procedures below.
- H. Adjust and fit products to provide a neat installation.
- I. Concrete Coring:
  - 1. Cutting work shall include saw-cutting of concrete and any other miscellaneous work, as required, core-drilling of concrete slabs and walls for structural work, or other items, and removal from the premises and site of all broken concrete and debris.
  - 2. Contractor shall use extreme caution not to cut, nick, or break any rebar or post tension systems during execution of work.
  - 3. Contractor shall select and employ a Testing Agency to furnish a pachometer, where required, and take readings for the location of reinforcing steel in existing concrete.
    - a. The selected Testing Agency shall meet with the approval of the District's Representative.
    - b. Pachometer readings shall be taken by the Contractor's employed Testing Agency to locate reinforcing steel, including but not limited to rebar and post-tension strand support members, in concrete to be cored and cut.
    - c. The contractor or his testing agency shall mark the locations of the reinforcing steel with bright paint. Mark all reinforcing steel within 3 ft of all cuts and cores, except at slabs on grade and stem walls.
    - d. Submit proposed methods for review by the District's Representative prior to proceeding as required elsewhere in this Section.
    - e. Cutting work shall be accurately located and shall be closely coordinated with the individual trades requiring such cutting work.
    - f. Cutting work shall be neatly and accurately performed with proper tools and equipment. Cuts shall be of minimum size required for the work.
    - g. Work to remain shall be properly protected to prevent damage from core-drilling and saw-cutting operations. Lubricant to be used with the equipment shall be channeled to prevent damage to work to remain.
    - h. At the completion of work all visible marks shall be removed to the satisfaction of the Construction Manager.

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- J. Gypsum Wall Board Penetrations: Provide circular penetrations maximum 1/8" inch larger than outer diameter of conduit being used. On both sides of the wall fill space between conduit and wall with joint compound, depth to match gypsum board thickness.
- K. All communications systems conduit openings in walls and floors are the responsibility of the Contractor. Install sleeves shown on the drawings when the concrete is poured. Any openings required after the concrete has set maybe core drilled per the procedures outlined above.
- L. Patching and Restoring Work
  - 1. General
    - a. Patching shall achieve security, strength, and weather protection, as applicable, and shall preserve continuity of existing fire ratings.
    - b. Upon completion of cutting and coring, clean remaining surfaces of loose particles and dust.
    - c. Patch existing construction by filling repairing, refinishing, closing up and similar operations. Patching includes the insertion or projection of other products in or from a surface.
    - d. Patch weather-exposed components in a manner that restores them to a weathertight condition.
    - e. Finish or refinish, as required, cut and patched surfaces to provide an even surface of uniform finish, color, texture, and appearance, matching existing adjacent. Finish complete surface plane, unless otherwise indicated. Over patched wall or ceiling surfaces, finish to nearest cutoff line for entire surface, such as intersection with adjacent wall or ceiling, beam, pilasters or to nearest opening frame, unless otherwise indicated. Finished surfaces shall not present a spotty, touched-up appearance
    - f. Finish or refinish, as required; cut and patch surfaces to match adjacent finishes. Patching shall successfully duplicate undisturbed adjacent finishes, colors, textures, and profiles. Where there is dispute as to whether duplication is successful or has been achieved to a reasonable degree, the District's Representative's judgment shall be final.
  - 2. Concrete
    - a. Preparation of Existing Surfaces: Use wire brush and air pressure to clean concrete of laitance, dirt, dust, and loose particles. Surface to received mortar shall be rough and reasonably even.
    - b. Mixing of Materials: Concrete bonding adhesive and patching mortar shall be prepared and mixed in accordance with the manufacturer's specifications and recommendations. Two (2) to five (5) parts sand shall be added to mortar as required to achieve the desired consistency for the type of work involved.
    - c. Patching of Concrete:
      - 1) Where removal of partitions, equipment, and other items has exposed holes in existing concrete floor slabs, fill in holes with new concrete and reinforce as necessary. Prepare slabs as required to provide clean, sound surfaces
      - 2) Patching of concrete work shall be expertly performed with adhesive and mortar materials specified. At completion, patched surfaces shall match adjacent surfaces as closely as possible.
      - 3) Concrete bonding agent and patching mortar shall be applied or installed where indicated on the drawings, or where otherwise required, in

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- accordance with the manufacturer's specifications and recommendations.
- 4) Where necessary to built-out cut, spalled, or chipped concrete surfaces, mix concrete bonding agent, mortar, and sand into a special mortar, and apply in layers as required to fill out or build up surfaces. Float, trowel, or texture new surfaces to match adjacent surfaces.
  - 5) Repair gravel pockets by cutting out (1 in. min.) to solid surface, form key and apply epoxy concrete adhesive before placing patching mortar; compact into place and neatly finish to exactly match surface texture. Honeycombed areas or gravel pockets which, in the Engineer's opinion, are too large and unsatisfactory for mortar patching as described above are to be cut to solid surfaces, keyed, and coated with epoxy concrete to produce firm bond and solid surface.
- d. Curing: Immediately after finishing patch approved curing compound according to manufacturer's instructions.

### **3.06 THROUGH PENETRATIONS SEALANT SYSTEMS**

- A. At a minimum, follow all manufacturer instructions. In case of discrepancy between manufacturer and contractor requirements, the more stringent shall apply. In the case of conflicting instructions, report any discrepancy to the District's Representative in a timely fashion so as not to impact the construction timeline.
- B. Application: Through Penetration Sealant Assemblies, Renenterable
  1. Zero-maintenance firestop assemblies shall be used when the pathway on one or both sides of the wall, ceiling or floor is open, such as J-hooks or cable tray.
  2. Communications cable tray or ladder rack shall not be continued through a fire-rated wall. Stop the tray or ladder rack, install multiple zero- maintenance firestop assemblies as needed, and continue the tray or ladder rack on the other side. Ensure grounding of the cable tray is continuous through the wall.
  3. Communications conduit sleeves through a single fire-rated wall shall not be used. For these applications, a zero-maintenance firestop assembly is required.
- C. Application: Firestopping for Conduits and Other Closed Pathways
  1. Firestopping is required for all fire-rated penetrations where a communications conduit or other closed pathway penetrates one or more membranes of a fire-rated wall floor or ceiling
  2. Required for all telecommunications outlets located on fire-rated walls. Systems shall be UL CLIV tested
- D. For all penetrations for communications openings through fire-rated walls, floors and ceilings, install the same manufacturer's product for that type of penetration throughout the project.
- E. Coordinate with all other trades prior to installation:
  1. To ensure that through penetration firestop systems are installed according to specified requirements.
  2. To ensure that sizing of openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems is appropriate.
- F. All penetrations through fire-rated building structures (walls, ceilings and floors) shall be sealed with an appropriate firestop system that at least matches the fire rating of the structure. This requirement applies to through penetrations (complete penetration) and

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membrane penetrations (through one side of a hollow fire-rated structure).

1. Any penetrating item i.e., riser slots, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.
  2. Through penetrations shall be sealed on both sides of the structure.
  3. Telecommunications outlet back-boxes installed in fire-rated walls shall be completely enclosed in an appropriate firestopping assembly within the wall.
  4. Conduit sleeves shall not be used for penetrating fire-rated floors, ceilings and walls. A zero-maintenance firestop assembly shall be used instead.
- G. Verify the locations of all fire-rated walls prior to installation.
- H. Firestopping assemblies must make a gas, smoke and water tight seal when activated in a fire.
- I. Multiple cable bundles planned to penetrate a fire-rated wall and entering the same space within 10 feet of each other shall be consolidated in to a single penetration, unless one or both penetrations are membrane penetrations.
- J. Ambient Conditions:
1. Do not install firestopping products when ambient or substrate temperatures are outside the limitations recommended by the manufacturer.
  2. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
  3. Maintain the minimum temperature before, during, and for a minimum 3 days after installation of materials.
- K. Schedule installation of firestopping after completion of the penetrating item (e.g., conduit) installation but prior to the covering or concealing of openings.
- L. Before beginning installation:
1. Examine and clean the affected 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.
- M. 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 firestopping materials and soiling as work progresses.
  3. Do not cover installed firestopping assemblies until inspected by the District's Representative.
- N. All firestop systems (including the cabling through them) and identification labels shall be installed prior to the District Representative's above-ceiling inspection.
- O. Labeling
1. At all firestop locations, install a permanent label near the firestop on each side of the wall, ceiling or floor. Labels shall be pre-printed and include:
    - a. Manufacturer of the firestop.
    - b. Name of product and UL System Number.
    - c. Name of installer and company name
    - d. Date of installation.
    - e. Rating of the wall/system (F and T ratings).

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2. One location may have multiple labels (e.g. for a firestop in the annular space around a conduit penetration and a firestop within the conduit around the cables).
3. Labels shall not be painted over or otherwise obscured or defaced.

### **3.07 RACEWAY INSTALLATION, GENERAL**

- A. Conduit not otherwise sized shall be selected to provide not greater than 30% fill with the cabling indicated for installation under the work of the Project.
- B. Raceway runs are shown schematically. Install concealed unless specifically shown otherwise. Supports, pull boxes, junction boxes and similar generally not indicated. Provide where designated.
  1. Install exposed conduit and raceway parallel and perpendicular to nearby surfaces or exposed structural members, and follow the surface contours. Level and square conduit and raceway runs.
  2. Raceway runs shall be mechanically and electrically continuous between all each equipment rack and utility demarcation point, receptacle and/or surface raceway strip, as applies.
  3. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box, or outlet by means of a locknut on the outside and a bushing on the inside or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter.
  4. Bends
    - a. All bends or elbows shall have a minimum radius as follows:

CONDUIT SIZE	MIN. RADIUS (INCHES)
3/4"	8
1"	12
1-1/4"	18
2"	24
2-1/2"	24
3"	30
3-1/2"	30
4"	30
5"	36
6"	42

- A. Use factory elbows or machine bends for conduit bends 1-1/4" and larger.
  1. Make bends and offsets so the inside diameter is not effectively reduced. Make bends in parallel or banked runs from the same center line so that the bends are parallel.
  2. Install at least one (1) 3/8", 200 pound strength nylon pull cord in all empty raceways.
  3. Raceways crossing building expansion joints or in straight runs exceeding 100 feet shall be provided with UL listed expansion fittings.
  4. Install conduit seals and drains to prevent accumulated moisture in conduits from entering Communications System enclosures.
- B. Do not install conduit in concrete slabs unless specifically directed by District's Representative. Embedded conduits in concrete slab walls, and columns shall be installed in center third between upper and lower layers of reinforcing steel as directed by the District's Representative.

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Space conduits 8" on center except at cabinet locations where slab thickness shall be increased as directed by the District's Representative.

- C. All conduits to be kept 12" away from steam or hot water lines. Install horizontal conduit and raceway runs below water and steam piping.
- D. Conduit dropping down to equipment shall be as straight as possible without any offsets, parallel or perpendicular to walls, ceilings and other building features.
- E. Conduit installed on any equipment shall be run symmetrical with the equipment and in such a manner as to:
  - 1. not to be exposed to damage;
  - 2. not interfere with access to components of the equipment that will interfere with maintenance operation or;
  - 3. not to be in a manner that the District deems detrimental to its operation.
- F. Whenever an installation such as that listed occurs, the Contractor shall make all necessary changes at no cost to the District.
- G. All cut ends of conduit, scratches, tool marks, etc. on any metallic raceway installed in the ground or on the exterior of the building shall be treated with two coats of specified Touch Up Paint/Tape.
- H. All raceways stubbing up into equipment or racks shall be sealed. Raceways with conductors shall be plugged with duct-seal. Spare raceways shall be capped. Prevent foreign matter from entering conduit and raceway; use temporary closure protection. Replace conduits containing concrete, varnish or other foreign material.
- I. Complete installation of conduit and raceway runs before starting installation of cables/wires within conduit and raceway.
- J. Use specified conduit and raceway fittings that are of types compatible with the associated conduit and raceway and suitable for the use and location. Join and terminate conduit and raceway with fittings designed and approved for the purpose of the conduit and raceway system and make up tight.
- K. Where chase nipples are used, align the raceway and coupling square to the box and tighten the chase nipple so no threads are exposed.
- L. Horizontal conduit or EMT runs, where required and permitted, shall be installed as close to ceiling or ceiling beams as practical.
- M. Conduit and EMT connected to wall outlets shall be run in such a manner that they will not cross water, steam or waste pipes or radiator branches.
- N. Conduit and EMT shall not be run through beams, purlins or columns except where permission is granted by District's Representative in writing.
- O. Bond installed metallic raceway in accordance with the requirements of the NEC.

### **3.08 HAZARDOUS LOCATIONS**

- A. Use rigid steel conduit only.
- B. Install UL listed sealing fittings that prevent passage of explosive vapors in accordance with the manufacturers written instructions. Locate fittings at suitable, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank coverplate having a finish similar to that of adjacent plates or surfaces.

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- C. Install raceway sealing fittings at the following points and elsewhere as indicated:
  - 1. Where conduits enter or leave hazardous locations.

### **3.09 REUSE OF EXISTING CONDUIT**

- A. Existing conduit is to be used as a pathway only where so shown on the drawings.
- B. Prior to beginning work involving the use of an existing conduit, the Contractor shall consult with the District's Representative in order to establish whether or not the conduit contains active service.
- C. If no active service exists within the conduit, all cable is to be removed, and work is to proceed.
- D. If active service does exist within the conduit and it has been determined that service needs to be disrupted, then work on that conduit shall not proceed until a schedule of service outage has been established by District's Representative. Once given permission to proceed, the Contractor shall within the time period of one (1) working day; remove the old cable, install, terminate and test the new cables, and notify the District's Representative the work using the specific conduit has been completed. The District's Representative shall be responsible for the disconnection and reconnecting of the active service cross-connects within the terminal closet(s).
- E. Conduit preparation procedure:
  - 1. Remove existing Wires and Cables (if any).
  - 2. Run a mandrel ½" smaller than the inside diameter of the conduit through the conduit receiving new wires and cables.
  - 3. If the specified size mandrel will not pass through the existing conduit, start with a smaller size mandrel and increase mandrel size until the specified sized mandrel will pass.
  - 4. Run a wire brush and clean rag with an outside diameter 1/8" larger than the inside of the conduit through the conduit receiving new wires and cables.
  - 5. Repeat above until conduit is clean and materials detrimental to the wire and cables to be installed no longer exit conduit with the clean rag.

### **3.10 TELEPOWER POLE**

- A. Prior to and during installation, refer to the system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets, which accompany system components as well as complete system instruction sheets, using whichever is applicable.
- B. Mechanical Security
  - 1. All systems shall be mechanically continuous and connected to all electrical outlets, boxes, and cabinets, in accordance with manufacturer's installation sheets.
- C. Electrical Security
  - 1. The system shall be electrically continuous and bonded in accordance with the California Electric Code for proper grounding.
- D. System Support
  - 1. System shall be securely supported at the ceiling and the floor in accordance with manufacturer's installation sheets.
- E. Completeness
  - 1. All systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused openings where wire is

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exposed shall be closed.

### **3.11 STATION CABLE PATHWAY INSTALLATION**

- A. Cut In Boxes and Station Outlet Boxes:
  - 1. Review the proposed installation height of the WAO's with the District Representative at each building, and within each building, at each major change in conditions prior to proceeding.
  - 2. Standard Work Area Outlets (WAO)
    - a. Unless otherwise noted on the plans, all cut in boxes and surface station outlet boxes installed for conventional application WAO's in walls with existing electrical receptacles that are installed within 18" of the floor are to be installed at +18" above finished floor) to center.
    - b. Where standard WAO's are to be installed in walls without electrical receptacles, install new WAO's at a height of 38" A.F.F.(above finished floor) to center,
  - 3. Wall Telephone WAO's
    - a. For WAO's indicated for use for telephone wall jacks, cut-in boxes are to be installed at a height of 47" A.F.F to top of box.
  - 4. All station outlets shall be installed so that their edges are parallel to the vertical and horizontal edges of the surface on which they are mounted.

### **3.12 WIRELESS ACCESS POINT ENCLOSURES**

- A. Mock Up
  - 1. Prior to installation mockup each wireless access point enclosure for aesthetic review by the District's representative. Obtain the District Representative's review prior to proceeding.
- B. Installation
  - 1. Conform with the Manufacturers Installation instructions and the following, whichever is more restrictive.
  - 2. Comply with the penetration details in the Drawings where penetrating existing exterior conditions.
  - 3. Select fasteners appropriate to mounting conditions, weight and wind load of enclosure and existing surfaces in accordance with Section 27 05 29 - Hangers and Supports for Communications Systems. Make attachment to building structural elements, not surface finish materials.
  - 4. Install enclosure plumb, parallel and aligned to surrounding surfaces. Center on surrounding architectural features were so directed by the District's Representative.
  - 5. Seal holes at base of enclosure to provide NEMA 4 functionality as indicated in the manufacturer's instructions.
  - 6. Paint enclosure and mounting hardware to exactly match surrounding surfaces. Protect the perimeter of the enclosure during the painting to ensure that operation of the door will not be impaired after painting.
- C. Touch Up and Cleaning
  - 1. Clean enclosures to like new condition. Provide Touch up painting and remove sealing debris as required following review by District's representative of installed condition.

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### **3.13 EXTERIOR JOINT SEALANT APPLICATION**

#### **A. Examination**

1. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.
2. Verify that joint sizes and surfaces are free of defects and acceptable for installation of joint sealants.
3. Verify joint dimensions and shapes to ensure they are within the sealant manufacturer's guidelines. Resolve any variances prior to installation. Do not proceed with sealant installation until the unsatisfactory conditions have been corrected.

#### **B. Preparation**

1. Thoroughly clean the areas that the new sealant will contact using a de-greasing solvent not harmful to the environment using the two-rag wipe technique. IPA (isopropyl alcohol) is not a degreasing solvent. The new sealant should have a minimum contact area of 1/4".
2. 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:
  - a. 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.
  - b. 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 the following:
    - 1) Concrete.
    - 2) Masonry.
  - c. Remove laitance and form-release agents from concrete.
  - d. 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 the following:
    - 1) Metal.
    - 2) Glass.
    - 3) Porcelain enamel.
    - 4) Glazed ceramic tile.
3. 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.

#### **C. Joint Priming**

1. Prime joint substrates where indicated or where recommended by joint sealant

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- manufacturer based on pre-construction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations.
2. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
  3. Allow primer to dry. Do not prime areas that cannot be sealed the same day.
- D. Installation of Sealant Backings
1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    - a. Do not leave gaps between ends of joint fillers.
    - b. Do not stretch, twist, puncture, or tear joint fillers.
    - c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.
- E. Installation Of Joint Sealants
1. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
  2. Sealant Installation Standard: Comply with recommendations of ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
  3. Perform acoustical sealant application work in accordance with ASTM C919.
  4. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
  5. Install joint backing to maintain the following joint ratios, but in no case less than 1/4 inch (6 mm):
    - a. Joints up to 1/2 inch wide: 1:1 width to depth ratio.
    - b. Joints Greater than 1/2 inch wide: 2:1 width to depth ratio; maximum 1/2 inch joint depth.
    - c. Sub-caulk joints that are deep, or joints without suitable backstop, to proper depth.
    - d. Protect side walls of joint (to depth of caulking) with bond breaker tape.
    - e. Install with adhesive on 2 faces in contact with sides of joints.
  6. Tooling of Non-sag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint.
    - a. Remove excess sealant from surfaces adjacent to joints.
    - b. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
    - c. Provide concave joint configuration per Figure 5A in ASTM C1193, unless otherwise indicated.
    - d. Provide flush joint configuration where indicated per Figure 5B in ASTM C1193.
- F. Cleaning

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1. Clean off excess sealants and 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.
  2. Leave finished work in a neat, clean condition with no evidence of spillovers onto adjacent surfaces.
- G. Protection
1. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion.
  2. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that installations with repaired areas are indistinguishable from original work.

**END OF SECTION**

**SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

- A. Cable Trays for Communications Cabling
  - 1. Cable Trays
  - 2. Cable Runways
  - 3. Basket Tray
- B. Cable Tray Support

**1.02 RELATED WORK UNDER OTHER SECTIONS**

- A. Section 27 05 00 - Common Work Results for Communications
- B. Section 27 05 26 - Grounding and Bonding for Communications Systems
- C. Section 27 05 29 - Hangers and Supports for Communications Systems
- D. Section 27 05 33 - Conduits and Backboxes for Communications Systems
- E. Section 27 05 39 - Surface Raceways for Communications Systems
- F. Section 27 05 48 - Noise and Vibration Controls for Communications Systems
- G. Section 27 05 53 - Identification for Communications Systems
- H. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
- I. Section 27 13 00 - Communications Interior Backbone Cabling
- J. Section 27 14 00 - Communications Outside Plant Backbone Cabling
- K. Section 27 15 00 - Communications Horizontal Cabling

**1.03 REFERENCES**

- A. Usage: In accordance with Division 1.
- B. Conform with the applicable portions of the following industry guidelines
  - 1. ASTM International
    - a. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - 2. National Electrical Manufacturers Association (NEMA)
    - a. NEMA FG 1 1-1998 Fiberglass Cable Tray Systems
    - b. NEMA VE 1 1-1998 Metal Cable Tray Systems.
    - c. NEMA VE 2 2001 Metal Cable Tray Installation Guidelines
  - 3. National Fire Protection Association (NFPA)
    - a. NFPA 70B Recommended Practice for Electrical Equipment Maintenance

**1.04 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications and the following:

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Procedures: In accordance with Division 1.
- B. Deliver cable tray systems and components carefully to avoid breakage, denting and scoring

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finishes. Do not install damaged equipment.

- C. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials should be unpacked and dried before storage. Replace any materials damaged by moisture exposure at no cost to the District.

### 1.06 SEQUENCING

- A. Not Used.

## PART 2 PRODUCTS

### 2.01 CABLE TRAY, CABLE RUNWAY AND BASKET TRAY

- A. Cable Tray
  - 1. Drawing and spec reference: CTxx-yy, where "xx" denotes nominal width of cable runway in inches and "yy" denotes nominal depth.
  - 2. Construction:
    - a. Two longitudinal Steel or aluminum members (side rails) with transverse members (rungs) mechanically fastened to the side rails.
    - b. Rungs 9" on center, unless otherwise noted and shall be capable of easy removal, reinstallation, or replacement if necessary.
    - c. Rung spacing in radiused fittings shall be 9" o.c. as measured at the center of the tray's width.
    - d. UL Classified splice kits.
    - e. Accessories. Provide with a complete system of accessories, including radiused corners at vertical and horizontal bends, section splice plates, expansion plates, blind-end plates, etc. Provide waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
  - 3. Approvals:
    - a. ASTM A513
    - b. National Electrical Code, Article 318
    - c. NEMA VE1 Class 12C minimum, or to suit indicated cable and raceway loads, whichever is greater.
  - 4. Manufacturers:
    - a. B-Line Redi-Rail Ladder Type Cable Tray with a complete system of accessories, including Ladder Drop-outs
    - b. Globe Tray
    - c. PW Industries
    - d. or equal.
- B. Cable Runway
  - 1. Drawing and spec reference: CR\*, where "\*" denotes nominal width of cable runway in inches.
  - 2. Construction:
    - a. Solid Steel Side Bar per ASTM A-36 or Tubular Steel Side Bar per ASTM A-513.
    - b. 1.5" x 0.375 minimum tubular side stringers.
    - c. UL Classified splice kits.
    - d. Designed to support at least 100 pounds per foot load with a Safe Working Load deflection of 1/2" or less.

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3. Finish: Telco gray powder coat or gold on zinc plating.
  4. Approvals:
    - a. ASTM A513
    - b. UL Classified as an equipment grounding conductor.
    - c. National Electrical Code, Article 318
  5. Manufacturers:
    - a. B-Line Telecom-Saunders SB-17.
    - b. Chatsworth Products Inc. 11275 series.
    - c. PW Industries
    - d. or equal.
- C. Cable Tray, Open Wire Frame
1. Drawing and spec reference(s): CTWxx-y, where xx denotes the tray width and y the depth of the tray, in inches.
  2. Construction
    - a. Welded wire mesh with continuous safety edge wire lip.
    - b. Mesh forms grid at nominally 2" by 4"
    - c. Carbon Steel
    - d. Electroplated zinc galvanized
    - e. All bends, seams and joints field fabricated from basic straight section pieces and splice components as supplied by the manufacturer.
    - f. Where supported from ceiling, supported at both sides in trapeze arrangement - centerline support not acceptable.
    - g. Provide a complete system of accessories, including bonding and grounding connections, conduit connectors, to terminate conduits extended to basket edge, radius shields to protect cabling at inside corners, and waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
    - h. Provides pathway complying with ANSI/TIA-569C and NEMA Publications VE1 & VE2
    - i. Meets requirements of National Electrical Code, Article 318
  3. Approvals:
    - a. NEMA Publications VE1 & VE2
  4. Manufacturers:
    - a. B-Line Wire Basket Runway
    - b. Cablofil
    - c. G.S. Metals Corp
    - d. PW Industries
    - e. or equal.
- D. Cable Tray, Fiberglass
1. Drawing and spec reference(s): CTFxx-y, where xx denotes the tray width and y the depth of the tray, in inches.
  2. Construction
    - a. Non-metallic, Non-conductive, Fiberglass Construction, suitable for continuous exterior exposure in a marine environment.
    - b. Deep structural C-form side channels
    - c. Ladder rungs at 9" o.c., u.o.n
    - d. All bends, seams and joints field fabricated from basic straight section pieces and

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splice components as supplied by the manufacturer.

3. Approvals:
  - a. UL Listed as a system
  - b. ASTM A568
  - c. NEMA Publication FG1
  - d. NEMA 12C
  - e. National Electrical Code, Article 318.3
  - f. Meets ASTM E-84 smoke density rating; Polyester 680, Vinyl Ester 1025
  - g. Class 1 Flame Rating and self-extinguishing requirements of ASTM D-635.
4. Manufacturers:
  - a. Enduro Composite Systems.
  - b. Robroy
  - c. P-W Industries
  - d. or equal.

### PART 3 EXECUTION

#### 3.01 CABLE TRAY APPLICATION

- A. Unless otherwise noted, communications cable tray installations shall conform to the following:
  1. Type CT - Within Communications Rooms (including ADF, BDF and IDF spaces)
  2. Type CTW - Horizontal station cabling outside of the communications rooms where shown on plans or where more than 100 cables are supported, whichever is greater.
  3. Type CR - Wherever vertical transitions from ceiling or floor sleeves are required within the Communications Rooms.

#### 3.02 INSTALLATION:

- A. Provide all required supports, fittings and accessories for a complete system as described in NEMA VE-2, by Code, manufacturer recommendation or as shown on the plans, whichever is most restrictive.
  1. Cable Tray. Provide with a complete system of accessories, including UL Classified splice kits, radiused corners at vertical and horizontal bends, section splice plates, expansion plates, blind-end plates, etc. Provide waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
    - a. Adjust rail position to align at dropout points and as directed by the District's Representative to coordinate with the installation of the District's materials and/or the work of other Projects.
  2. Basket Tray
  3. For wire basket tray, provide a complete system of accessories, including bonding and grounding connections, conduit connectors, to terminate conduits extended to basket edge, radius shields to protect cabling at inside corners, and waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
- B. Bond sections to one another and to building ground.
- C. Access Clearance. Maintain access for use by District's personnel to tray as described below. Coordinate installation with work of structural, mechanical, plumbing/fire protection and electrical trades to maintain required access.
  1. Unless shown otherwise on the plans, provide a clear access of at least 24" wide along

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- one side of each tray for use by District's personnel.
- 2. Unless shown otherwise on the plans, installation to maintain at least 12" vertical clearance over the top of each tray for use by District's personnel.

### **3.03 SUPPORT**

- A. Support in accordance with the most restrictive of the following:
  - 1. California Building Code.
  - 2. Contractor's engineered means of engineered support submitted in accordance with the requirements of 27 05 00 - Common Work Results for Communications and Section 27 05 29 Hangers and Supports for Communications Systems.
  - 3. Metallic Cable Tray: NEMA VE 2-2001, or latest edition
  - 4. Fiberglass Cable Tray: NEMA FG-1-1998, or latest edition.
- B. Provide lateral sway bracing as required by Code.

**END OF SECTION**

## **SECTION 270539 - SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS**

### **PART 1 GENERAL**

#### **1.01 SCOPE OF WORK**

- A. Metallic Surface Raceways
- B. Non-Metallic Surface Raceways
- C. Surface Raceway Fittings
- D. Overfloor Raceway

#### **1.02 RELATED WORK UNDER OTHER SECTIONS**

- A. Section 27 05 00 - Common Work Results for Communications
- B. Section 27 05 26 - Grounding and Bonding for Communications Systems
- C. Section 27 05 29 - Hangers and Supports for Communications Systems
- D. Section 27 05 33 - Conduits and Backboxes for Communications Systems
- E. Section 27 05 36 - Cable Trays for Communications Systems
- F. Section 27 05 48 - Noise, Vibration and Seismic Controls for Communications Systems
- G. Section 27 05 53 - Identification for Communications Systems
- H. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
- I. Section 27 13 00 - Communications Interior Backbone Cabling
- J. Section 27 14 00 - Communications Outside Plant Backbone Cabling
- K. Section 27 15 00 - Communications Horizontal Cabling

#### **1.03 REFERENCES**

- A. Usage: In accordance with Division 1.
  - 1. American National Standards Institute (ANSI)
    - a. ANSI/TIA-569-C (2012) Telecommunications Pathways and Spaces
    - b. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
  - 2. Underwriters Laboratories, Inc. (UL)
    - a. UL 94 -1996 (R 2001), Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
    - b. UL 514C 1988 (R 1989) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

#### **1.04 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

### **PART 2 PRODUCTS**

#### **2.01 GENERAL**

- A. Products provided under the work of this Section shall provide the following

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minimum characteristics:

1. Approvals
  - a. U.L Listed
  - b. Multi-chamber surface raceway shall conform to NEC 352B for simultaneous power and telecommunications use.
2. Meet or exceed the requirements of ANSI/TIA-569-C for a surface raceway system
3. Fittings shall incorporate radiussed corners such that wiring cannot be placed therein with bend radius less than the minimum bend radius specified in ANSI/TIA-568C.1.
4. Raceway base shall be designed to be securely fastened to mounting surface per manufacturer's recommendations using mechanical fasteners. Systems requiring use of adhesive fasteners will not be accepted.
5. Raceway system shall include fittings for connection and change of raceway direction and/or plane of installation.
6. Available in-line raceway connector fittings shall include at least:
  - a. External Elbow
  - b. Flat Elbow
  - c. Internal Elbow
  - d. End Cap
  - e. Splice Cover
  - f. Tee
  - g. Cable clips to retain contents in overhead installation. Alternatively, provide separate cable ties and independent restraint for same.
7. System shall accommodate connection to trade standard boxes and fittings through accessory boxes and transition pieces
8. Trade connections, device boxes and mounting systems shall not reduce fill capacity, except where specifically scheduled.
9. System shall include device plates of types to meet requirements shown on Communication Systems drawings.
10. Available device mounting boxes shall include at least:
  - a. Raised Device Box
  - b. 2-gang Raised Device Box
  - c. In-Line Device Box
11. System shall include device plates of types to meet requirements shown on Communication Systems drawings.
12. Available device plates shall include at least:
  - a. Single Receptacle Plate
  - b. Duplex Receptacle Plate (NEMA 106)
  - c. Duplex - Duplex (Quadplex) Plate
  - d. Ring to secure 3rd party communications plates and jack subframes as specified in Section 27 15 00.

### **202 SURFACE RACEWAY**

#### **A. Metallic Surface Raceway**

1. Drawing and Specification Reference: #MSR\*, where "#" denotes number of chambers, "\*" denotes cross sectional area of each chamber in square inches.
2. Construction

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- a. Capacity:
  - 1) One chamber, 1.4 inches:
    - (a) Drawing and reference designation: 1MSR-1.4.
    - (b) Minimum cross-sectional area of 1.4 square inches.
  - 2) One chamber, 6.75 inches:
    - (a) Drawing and reference designation: 1MSR-6.75.
    - (b) Minimum cross-sectional area of 6.75 square inches.
  - 3) One chamber, 16.5 inches:
    - (a) Drawing and reference designation: 1MSR-16.5
    - (b) Minimum cross-sectional area of 16.5 square inches.
  - 4) Two chamber, 3.3 inches:
    - (a) Drawing and reference designation: 2MSR-3.3
    - (b) Minimum cross-sectional area of each chamber equal to 3.3 square inches.
  - 5) Two chamber, 8 inches:
    - (a) Drawing and reference designation: 2MSR-8
    - (b) Minimum cross-sectional area of each chamber equal to 8 square inches.
  - 6) Three chamber, 5.5 inches:
    - (a) Drawing and reference designation: 3MSR-5.5
    - (b) Minimum cross-sectional area of each chamber equal to 5.5 square inches.
- b. Material: Galvanized steel or anodized aluminum.
- c. Provide Ivory color finish, unless otherwise noted.
- d. Two chamber surface raceway shall have two adjacent chambers or equal area as specified separated by a removable horizontal dividers
- e. Three chamber surface raceway shall have three adjacent chambers separated by removable horizontal dividers. Removal of one of the two dividers to result in a two chamber raceway systems with useable cross-sectional areas of 2/3'rds and 1/3 of the overall raceway capacity.
- f. System and installation shall not compromise separation of Class 1 and low voltage services.
- g. Keyed cover plate shall require tool for removal.
3. Manufacturers:
  - a. One chamber, 1.4 inches:
    - 1) Wiremold 2400 System (Design Basis).
    - 2) or equal (no known equal).
  - b. One chamber, 6.75 inches:
    - 1) Wiremold V4000 System (Design Basis).
    - 2) or equal (no known equal).
  - c. One chamber, 16.5 inches:
    - 1) Wiremold V6000 System (Design Basis)
    - 2) or equal (no known equal).
  - d. Two chamber, 3.3 inches:
    - 1) Wiremold V4000 System with G4000D divider and G4001D divider clips as required (Design Basis).
    - 2) or equal (no known equal).

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- e. Two chamber, 8 inches:
    - 1) Wiremold V6000 System with G6000D divider and G6001D divider clips as required (Design Basis).
    - 2) or equal (no known equal).
  - f. Three chamber, 5.5 inches:
    - 1) Wiremold V6000 System with two G6000D dividers and G6001D divider clips as required (Design Basis).
    - 2) or equal (no known equal).
- B. SURFACE RACEWAY, NON-METALLIC:
- 1. Drawing & Spec Reference: #SR\*, where "#" denotes number of chambers, "\*" denotes cross sectional area of each chamber in square inches.
  - 2. Construction
    - a. Single chamber, 1 square inch:
      - 1) Drawing and reference designation: 1SR-1
      - 2) Two piece construction or hinged single piece.
      - 3) System components to provide at least a one (1) inch bend radius at corners.
    - b. Dual chamber, 2 square inches:
      - 1) Drawing and reference designation: 2SR-2
      - 2) Two piece construction.
      - 3) At least 3.7 square inches of fill areas in each of two chambers.
      - 4) System components to provide at least a one (1) inch bend radius at corners.
    - c. Three chamber, 3/4 inch:
      - 1) Drawing and reference designation: 3SR-.75
      - 2) Two piece construction.
      - 3) Three chamber, 2.5 inch:
      - 4) Drawing and reference designation: 3SR-2.5 System components to provide at least a one (1) inch bend radius at corners.
    - d. Color: White or Ivory, to best match surrounding surfaces. Submit color options to District's Representative for selection.
    - e. Three chamber surface raceway shall have three adjacent chambers separated by removable horizontal dividers. System and installation shall not compromise separation of services.
    - f. Keyed cover plate shall require tool for removal.
  - 3. Approvals:
    - a. Plastic meeting UL 94 V-0 flammability rating.
  - 4. Manufacturers, subject to the above:
    - a. One chamber, 1 inch (1SR-1)
      - 1) Wiremold.PN10.
      - 2) Panduit LDP-10.
      - 3) Hubbell.
      - 4) or equal.
    - b. Two chamber, 2 inch (2SR-2)
      - 1) Wiremold 5400B Series (Design Basis).
      - 2) Hubbell.
      - 3) or equal.

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- c. Three chamber, 3/4 inch (3SR-.75)
  - 1) Wiremold 5400 Series with 5400 BD Base (Design Basis).
  - 2) Hubbell Mediatrak System.
  - 3) or equal.
- d. Three chamber, 2.5 inch (3SR2.5)
  - 1) Wiremold 5500 Series with 5500BD Base (Design Basis).
  - 2) Hubbell Mediatrak 10.
  - 3) or equal.

### **203 OVERFLOOR RACEWAY**

- A. Over Floor Raceway System
  - 1. Drawing References: Overfloor Raceway
  - 2. Minimum Features, Functions, Construction:
    - a. Intended by Manufacturer for use as a permanently installed overfloor raceway.
    - b. Provides power, communication, and A/V wiring to areas where in-floor or ceiling distribution are not accessible options.
    - c. Multiple channel base. Four-channel raceway provides space for multiple combinations of power, communication and A/V to be provided through a single raceway installation.
    - d. Black powder coat finish. Durable textured finish resists scuffing and scratches.
    - e. Multiple options for communication and A/V connectivity:
      - 1) System accepts manufacturers device plates that provide connectivity to a wide range of devices from leading communication and A/V providers.
    - f. Attaches directly to floor covering. Works with carpet, tile, wood, etc. so there is no need to remove or alter existing floor coverings.
    - g. Multiple transition options. Transition fittings are available to industry standard wall surface raceway systems and telepower poles.
    - h. Tamper-resistant system. Raceway cover is difficult to remove without the proper tools, discouraging unwanted access to raceway-provided services.
    - i. Meets ADA Accessibility Guidelines. Low profile, unobtrusive design meets the ADA Accessibility Guidelines that pertain to ADA Standard 4.5 which addresses changes in floor and ground surface levels.
  - 3. Manufacturer
    - a. Legrand Wiremold OFR. Provide complete system of fittings as required to meet field conditions
    - b. Or equal (no known equal).

### **PART 3 EXECUTION**

#### **301 APPLICATION**

- A. Surface raceway installed in fire rated exitways shall be metal surface raceway.

#### **302 GENERAL INSTALLATION:**

- A. Install complete raceway system as shown on drawings, including track, cover plate, device boxes, radiused inside and outside elbows and manufacturer's category and fiber cabling guideway fittings, splice plates, T's, transitions and extension rings and end caps as required.

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- B. Any existing surface raceway and/or exposed cabling along the indicated pathway of the raceway to be installed shall be removed prior to the installation of the new raceway. If the existing cabling contains active service, then Contractor shall consult with the District's Representative as to how best maintain the existing service before proceeding with the work.
- C. Provide and install the proper factory fabricated corners, support clips, end connectors, etc. as required. Support and restrain cabling as required to suit installation conditions. Removal of the raceway cover shall not result in cabling dropping out of the raceway.
- D. Corners and joints are to be cut neatly and finished using connector components of specified system. Where components are not available using specified system, to meet requirements of drawings, provide cleanly mitered joints, EMT and/or surface backboxes specified elsewhere herein.
- E. All installed surface raceway shall be inspected for marks, scratches, gaps between sections or improper fitting of connector parts. All such damage shall be repaired to the District's Representatives satisfaction, or the raceway shall be removed and replaced.
- F. Remove sharp corners and edges prior to installation of cable.
- G. Attachment of raceway to walls, floors, and partitions:
  - 1. Attach raceway to the supporting surface with mechanical fasteners applied to building structure per the most restrictive of manufacturer's directions, Code, or these provisions.
  - 2. All surface raceway shall be installed so that its edges are parallel to the vertical or horizontal edge of the surface on which they are mounted. All surface raceway, found not to be installed in this manner, shall be removed and re-installed correctly.
  - 3. Surface raceway shall be secured at 2'-0" intervals (2 spaced screws for 2" and wider raceways) with wood screws into wooden framing or self drilling wall anchors (ITWBildex "Heavy Duty E-Z Toggle", no known equal) into sheetrock or plastic inserts with pre-assembled drive screw for concrete (ITT-HOLUB "HI-DRIVE" nail anchors, no known equal) Powder (explosive charge) driven anchors are not acceptable. The use of adhesives as the sole means for fastening to any surface is not allowed.
  - 4. Screws used in fastening surface raceway shall be no less than 3/4" in length.
  - 5. The proper support clips, as called for by the manufacturer, for securing surface raceway to walls or floors are to be used per the manufacturer's instructions.
- H. Placement of surface raceway:
  - 1. As indicated on the plans, all vertical runs from surface station outlets shall drop directly from a horizontal run to the station outlet unless noted otherwise.
    - a. Raceway base and cover sections shall be minimum 24" long unless the run is shorter.
    - b. Off-set cover joints from base joints by at least 12".
    - c. Miter joints shall have gaps of less than 1/16". Caulk gaps after completion of wiring installation.

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**END OF SECTION**

## **SECTION 270543 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, and set up of the Communications System Raceway, Conduit and Backbone work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, contiguous working raceway systems.
- B. Communications Outside Plant Ductwork - refer to the drawings for demarcation of the work of this Project.
  - 1. Communications Outside Plant Ductwork.
  - 2. Communications Manholes
  - 3. Communications Pullboxes and Vaults
  - 4. Connection of underground ductbanks to existing ductbank
  - 5. Connection of underground ductbanks to buildings and new and existing manholes

#### **1.02 RELATED WORK IN OTHER SECTIONS:**

- A. Section 31 23 33 - Trenching And Backfilling

#### **1.03 REGULATORY REQUIREMENTS**

- A. California Electric Code

#### **1.04 REFERENCES**

- A. Usage: In accordance with Division 1.
- B. American Association of State Highway and Transportation Officials (AASHTO)
  - 1. AASHTO M-306 Standard Specification For Drainage, Sewer, Utility, And Related Castings
- C. American National Standards Institute (ANSI)
  - 1. ANSI C80.1 1990 Rigid Steel Conduit - Zinc Coated
  - 2. ANSI /SCTE 77 2007 Specification for Underground Enclosure Integrity
- D. BICSI
  - 1. 2004 Customer Owned Outside Plant Design Manual
- E. National Electrical Manufacturers Association (NEMA)
  - 1. NEMA 250-2003 Enclosures for Electrical Equipment (1000 Volts Maximum)
  - 2. ANSI/NEMA FB 1-2003 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
  - 3. FB 2.10 2000 Selection and Installation Guidelines For Fittings For Use With Non-Flexible Metallic Conduit Or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, And Electrical Metallic Tubing).
  - 4. FB 2.20 2000 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
  - 5. NEMA FG 1 1-1998 Fiberglass Cable Tray Systems
  - 6. NEMA ICS 6 2001 Industrial Controls and Systems Enclosures
  - 7. NEMA RN 1 1998 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

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8. NEMA TC 2 2003 Electrical Polyvinyl Chloride (PVC) Conduit
9. NEMA TC 3 1999 PVC Fittings for Use with Rigid PVC Conduit and Tubing
10. NEMA TC 6&8 2003 PVC Plastic Utilities Duct for Underground Installations
11. NEMA TC 7 2000 Smooth Wall Coilable Polyethylene Electrical Plastic Duct
12. NEMA TC 9 1999 Fittings for ABS and PVC Plastic Utilities  
Duct for Underground Application
13. NEMA TC 14 1984(R 1997) Filament-Wound Reinforced Thermosetting  
Resin Conduit and Fittings
14. NEMA TC 19 2001 Nonmetallic Riser U-Type Guards
15. NEMA VE 1 1-1998 Metallic Cable Tray Systems.
16. NEMA VE 2 2001 Cable Tray Installation Guidelines
17. Underwriters Laboratories, Inc. (UL)
  - a. UL 6 2004 Electrical Rigid Metal Conduit - Steel
  - b. UL 360 1986 (R 2003) Liquid-Tight Flexible Steel Conduit
  - c. UL 514A 1991 (R 2004) Metallic Outlet Boxes
  - d. UL 514B 1989 (R 2004) Conduit, Tubing, and Cable Fittings
  - e. UL 514C 1988 (R 1996) Nonmetallic Outlet Boxes, Flush-Device  
Boxes, and Covers.
  - f. UL 651 1989 (R 1995) Schedule 40 and 80 Rigid PVC Conduit.

### 1.05 SUBMITALS AND SHOP DRAWINGS

- A. Procedures: In accordance with Division 1.

### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Procedures: In accordance with Division 1.
- B. Duct
  1. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances.
  2. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

## PART 2 PRODUCTS

### 2.01 DUCTBANK CONSTRUCTION

- A. PVC Conduit
  1. Drawing and Spec Reference: PVC.
  2. Construction:
    - a. 4" trade diameter, unless otherwise noted.
    - b. Poly-vinyl chloride.
    - c. Schedule by Application
      - 1) Straight segments, Schedule 40.
      - 2) Flat elbows, Schedule 40.
      - 3) Vertical elbows sweep up to grade, Schedule 80.
      - 4) Above grade, Schedule 80.
    - d. Elbows.
      - 1) Where innerduct liner is scheduled - CRSC.
      - 2) Elsewhere, Schedule 80.

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- 3) 90° C rated.
- 4) Solvent welded joints, joints by pipe manufacturer.
- e. Application.
  - 1) Soil Backfill/Direct Burial
    - (a) RUS Type II, Type C or Type DB
    - (b) Schedule 40.
  - 2) Concrete Encasement:
    - (a) PVC Type DB-120,
    - (b) RUS Type I, Type B or Type EB
    - (c) Any meeting Soil Backfill/Direct Burial.
  - 3) Boring
    - (a) HDPE.
    - (b) RUS Type Flexible Plastic.
- f. Performance:
  - 1) Tensile Strength: 7,000 psi at 73.4° F.
  - 2) Flexural Strength: 11,000 psi.
  - 3) Compressive Strength: 8,600 psi.
- g. Approvals:
  - 1) RUS Listed for Telephone Cable Installation 5-99 Edition, or latest release thereof.
  - 2) NEMA TC-2, PVC Type EPC-40 and EPC-80.
  - 3) NEMA TC-3.
  - 4) NEMA TC14 Fiberglass Conduit.
  - 5) UL 514
  - fittings. 6) UL 651.
  - 7) ANSI C33.91.
- h. Manufacturers:
  - 1) RUS Listed:

MANUFACTURER	RUS LISTED FOR	MANUFACTURER PART NUMBER
ALLWIRE, INC.	FLEXIBLE PLASTIC	ALLDUCT
AMERICAN PIPE & PLASTICS	PLASTIC	TYPE B, C, AND D
	PLASTIC	TYPE EB AND DB
	PLASTIC	PVC MULTI-DUCT (2,3,4 AND 6-WAY)
AMERICON INTERNATIONAL	FLEXIBLE PLASTIC	HDPE DUCT
	PLASTIC	PVC TYPE C
APACHE PLASTICS, INC.	PLASTIC	TYPE EB AND TYPE DB
ARMCO	PLASTIC	SMOOTH-COR TYPE B AND TYPE C
ARNCO	FLEXIBLE PLASTIC	HDPE CONDUIT

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BAY PLASTICS, INC.	PLASTIC	TYPE B AND TYPE C
BRISTOLPIPE	PLASTIC	TYPE B, C, AND D
	PLASTIC	TYPE EB AND TYPE DB
CAN-TEX	PLASTIC	TYPE EB AND TYPE DB
	PLASTIC	TYPE B, C, AND D
CARLON	PLASTIC	TYPE EB AND TYPE DB
	PLASTIC	TYPE B, C, AND D
	PLASTIC	MULTI-GARD
CERTAIN-TEED PRODUCTS CORP.	PLASTIC	TYPE EB AND TYPE DB
CIBA-GEIGY	FIBERGLASS	T & D CONDUIT
CONDUX INTERNATIONAL, INC.	CONCRETE	CONDUX
	PLASTIC	TYPE EB AND TYPE DB
CSR POLYPIPE	FLEXIBLE PLASTIC	HDPE DUCT
DURA-LINE	FLEXIBLE PLASTIC	HDPE DUCT
EAGLE PACIFIC INDUSTRIES, INC.	PLASTIC	TYPE EB AND TYPE DB
	FLEXIBLE PLASTIC	HDPE COILED DUCT
ENDOT INDUSTRIES	FLEXIBLE PLASTIC	HDPE DUCT
FREEDOM PLASTICS, INC.	PLASTIC	TYPE C
HERCULES, INC.	FLEXIBLE PLASTIC	CORFLO PLASTIC CONDUIT
HURLBUT PLASTIC PIPE	PLASTIC	TYPE C

INGOMAR PLASTIC PIPE	PLASTIC	TYPE B AND TYPE C
J-M MANUFACTURING COMPANY	PLASTIC	TYPES C, EB, AND DB
KYOVA	PLASTIC	TYPE EB AND TYPE DB
LCP NATIONAL PLASTICS, INC.	PLASTIC	TYPE EB AND TYPE DB
	PLASTIC	TYPE B AND TYPE C
NORTHERN PIPE PRODUCTS	PLASTIC	TYPE B, C, AND D
OMNI	FLEXIBLE PLASTIC	HDPE DUCT
PETROFLEX	FLEXIBLE PLASTIC	HDPE DUCT
	FLEXIBLE PLASTIC	CORRUGATED HDPE DUCT
PHILLIPS PRODUCTS CO., INC.	FLEXIBLE PLASTIC	DRISCON 3200
PHONE DUCS	PLASTIC	MULTIPLE PLASTIC CONDUIT (4, 6, & 9 WAY)
PLEXCO	FLEXIBLE PLASTIC	PLEXCO DUCT
PWPIPE	PLASTIC	TYPE EB AND TYPE DB

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<b>PYRAMID INDUSTRIES, INC.</b>	<b>PLASTIC</b>	<b>TYPE EB AND TYPE DM</b>
	<b>FLEXIBLE PLASTIC</b>	<b>HDPE CONDUIT</b>
<b>QUAIL PLASTICS</b>	<b>PLASTIC</b>	<b>TYPE EB AND TYPE DB</b>
<b>QUEEN CITY PLASTICS</b>	<b>PLASTIC</b>	<b>TYPE EB AND TYPE DB</b>
<b>RIVER CITY PLASTICS</b>	<b>PLASTIC</b>	<b>TYPE EB AND TYPE DB</b>
<b>SEDCO</b>	<b>PLASTIC</b>	<b>TYPE EB AND TYPE DB</b>
<b>SOUTHERN PIPE, INC.</b>	<b>PLASTIC</b>	<b>PVC TYPES EB, DB, AND SCH. 40</b>
<b>TAMAQUA CABLE PRODUCTS</b>	<b>FLEXIBLE PLASTIC</b>	<b>HDPE DUCT</b>
<b>TRIDYN INDUSTRIES</b>	<b>PLASTIC</b>	<b>TYPE EB AND TYPE DB</b>
<b>VASSALLO INDUSTRIES</b>	<b>PLASTIC</b>	<b>TYPE B AND TYPE C</b>
<b>WESFLEX</b>	<b>FLEXIBLE PLASTIC</b>	<b>FLEX-CON</b>

- A. or equal
- B. Fiberglass Conduit
  - 1. Drawing Reference: Fiberglass
  - 2. Construction:
    - a. Trade Standard Sizes
    - b. Meets NEMA TC 14
    - c. Complete system of joints and threaded steel conduit couplers
  - 3. Manufacturers:
    - a. TVC Communication/Vikimatic Fiberglass Conduit
    - b. Champion Fiberglass
    - c. FRE Composite
    - d. or equal.

## **2.02 FITTINGS**

- A. Couplings, adapters, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.
- B. Fitting Types
  - 1. Expansion Fittings, 12", Metallic:
  - 2. Function: At road or bridge expansion joints requiring up to 12" of expansion compensation.
  - 3. Construction
    - a. Steel, hot dip galvanized.
    - b. Nylon wear bushings
    - c. O-ring seal
    - d. Bonding jumper
  - 4. Manufacturers:
    - a. O-Z Gedney Type AX, Type AX-8, and Type EX fittings with Type BJ Bonding Jumper.
    - b. TVC/Vikimatic VB0285X series.
    - c. Or Equal.

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- C. Expansion Fittings, 6", Non-metallic:
  - 1. Function: At road or bridge expansion joints requiring up to 6" of expansion compensation.
  - 2. Construction
    - a. Fiberglass
    - b. Provide bonding jumper.
  - 3. Manufacturers:
    - a. TVC Communications HW or Extra Heavy Wall Expansion Joint.
    - b. Vikimatic
    - c. FRE Composites, Inc.
    - d. Or Equal.
- D. Caps, Underground Conduit Stubs
  - 1. Provide at each location indicated for future expansion.
  - 2. Watertight.
  - 3. Manufacturers:
    - a. Carlon E985N
    - b. Vikimatic
    - c. or equal by manufacturers listed in this Section for underground ductbank construction.

### 2.03 UNDERGROUND STRUCTURES

- A. Vaults, PullBoxes and Manholes, Precast, General
  - 1. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes, boxes and handholes.
  - 2. Construction
    - a. General
      - 1) Castings shall be free from warp and blow holes that may impair strength or appearance.
      - 2) Structures shall be precast to the design and details indicated, precast monolithically and placed as a unit, or structures may be assembled in sections, designed and produced by the manufacturer in accordance with the requirements specified.
      - 3) Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
      - 4) Structure top and wall shall be of a uniform thickness of not less than 4 inches except at knockouts.
      - 5) The minimum concrete cover for reinforcing steel shall be 2 inches.
      - 6) All steel, except reinforcing steel, shall be hot dip galvanized after fabrication.
      - 7) Knockouts & Windows
        - (a) Thin-walled knock-out panels designed for future duct bank entrances are permitted.
        - (b) Sides of precast windows shall be a minimum of 4 inches from the inside surface of adjacent walls, floors, or ceilings.
        - (c) Form of the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope.

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- (d) Provide welded wire-fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes.
    - (e) Provide additional reinforcing steel comprised of at least 2 No. 4 bars around window openings.
  - 8) Extension Rings
    - (a) Provide extension rings as-required to extend from finished grade to communications utilities.
  - 9) Bottom and Drain Sumps
    - (a) Provide solid concrete bottom surface.
    - (b) Provide drain sumps for precast structures a minimum of 12 inches in diameter and 4 inches deep.
- 3. Joints:
  - a. Provide tongue-and-groove or shiplap joints on mating edges of precast components.
  - b. Design joints to firmly interlock adjoining components and to provide waterproof junctions, and adequate shear transfer.
  - c. Seal joints watertight using preformed plastic strip conforming to AASHTO M198, Type B.
- 4. Frames and Covers
  - a. Covers to match across all utilities.
  - b. Provide fiber composite lids at pedestrian rated covers, H-20 steel slip resistant covers otherwise.
  - c. Labeling
    - 1) Provide labeling as follows:
      - (a) "Communications"
      - (b) District's Manhole or Vault No, as shown on drawings or provided to Contractor prior to vault order placement.
    - 2) Labeling shall be:
      - (a) Cast in concrete lids
      - (b) Written in weld on steel lids
      - (c) Alternatively, for pedestrian grade vault lids and for the vault number only, provide ½" tall, 1/8" min. thickness lamacoid label, rivet attached to box top in recess area below surface of lid.
- 5. Pulling-In-Irons
  - a. Steel bars bent in the form indicated and cast in the walls and floors.
  - b. Install a pulling-in iron in the wall opposite each duct line entrance at walls, not less than 6 inches above or below, and opposite the ducts entering the manhole.
  - c. Pulling-in irons shall project into the manhole approximately 4 inches, or be cast in a pocket. Iron shall be hot-dipped galvanized after fabrication.
- 6. Cable Racks and Arms
  - a. Provide nonmetallic cable racks:
    - 1) Vaults and pullboxes. Minimum two (2), at each vault face 24 inches or longer, at least one (1) each face otherwise.
    - 2) Manholes. Provide AT&T standard arrangement of cable racks at each manhole.
      - (a) Provide two cable racks arms - minimum 12" arms - for each

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cable rack provided at each manhole or vault as required above.

**B. Underground Pull Boxes and Vaults, Concrete with Diamond Plate Steel or Concrete Lids**

1. Drawing and Specification References:
  - a. PB1P
  - b. PB1T
  - c. PB2P
  - d. PB2T
  - e. PB3T
2. Minimum Size
  - a. PB1\* -  
14x20      b.
  - PB2\* -  
18x30      c.
  - PB3\* - 36x60
  - d. Provide scheduled or larger size.
  - e. Provide extension rings as required to meet required depth.
3. Minimum Load Performance:
  - a. PB\*P - where \* is the vault size: Manufacturer's Parkway/Pedestrian Box/Lid or using Polymer Concrete Box lid meeting ANSI/SCTE 77-2007 Tier 8.
  - b. PB\*T - where \* is the vault size: Per AASHTO H-22.
4. Lid Construction:
  - a. As scheduled on the plans and in the schedule of applications in Part 3.
  - b. Labeling "Communications" in addition to the vault number identified by the District.
5. Solid Bottom, with sump as indicated on the plans.
6. Sidewall Duct Entries with bell end fittings.
7. Cover Components
  - a. PB1 and PB2 Size: One piece construction
  - b. PB3 Size: Two piece hinged lids with torsion spring lifters.
8. Manufacturers:
  - a. Oldcastle Precast
  - b. Brooks Products
    - 1) 1P & 1T: 5 Series and extension rings as required
    - 2) 2P & 2T: 67 Series and extension rings as required
    - 3) 3T: 400 Series with 11C Type Lid.
  - c. Jensen PreCast
    - 1) PB1P: P9 with FL9D lid, P9BA base and extension rings as required.
    - 2) PB1T P9 with P9-61 lid, P9BA base and extension rings as required
    - 3) PB2P: P36 with FL36D cover, P36BA base and extension rings as required
    - 4) PB2T: P36 with P36-61D lid, P36BA base and extension rings as required
    - 5) PB3T: 35TA
  - d. Utility Vault Company, Inc./Oldcastle Precast
    - 1) PB3T: PTS-3660, with H-20-44 loading cover, with 3660-06 and 3660-12 extensions as required.
  - e. Oldcastle Precast - Christy
  - f. Associated Concrete Products
  - g. Forni Corporation.

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- h. Or equal.
- C. Underground Pull Boxes and Vaults, Polymer Concrete
  - 1. Drawing and Specification References - where the option to use of composite vault assemblies is indicated on the plans and per Part 3 of these specifications
    - a. PB1P
    - b. PB1T
    - c. PB2P
    - d. PB2T
    - e. PB3T
  - 2. Minimum Size (inches)
    - a. PB1\* - 14x20
    - b. PB2\* - 18x30
    - c. PB3\* - 36x60
    - d. Provide scheduled or larger size.
    - e. Provide extension rings as required to meet required depth.
  - 3. Cover Components
    - a. PB1 and PB2 Size: One piece construction
    - b. PB3 Size: Two piece hinged lids with torsion spring lifters.
  - 4. Construction:
    - a. Polymer concrete cover and body.
  - 5. Labeling
    - a. Labeling "Communications" in addition to the vault number identified by the District.
  - 6. Sidewall Duct Entries with bell end fittings.
  - 7. Solid bottom with sump as indicated on the plans.
  - 8. Minimum Load Performance:
    - a. PB\*P - where \* is the vault size: ANSI/SCTE 77-2007 Tier 8.
    - b. PB\*T - where \* is the vault size: At indicated dirt roads, per ANSI/SCTE 77-2007 Tier 22.
  - 9. Manufacturers
    - a. Armorcast Polymer Concrete Vaults
    - b. Oldcastle Enclosure Solutions H-Series
    - c. New Basis
    - d. Quazite
    - e. Hubbell Power Systems
    - f. Or equal.

### 2.04 MISCELLANEOUS UNDERGROUND PRODUCTS

- A. Cable Warning Tape
  - 1. Provide
    - a. 6 inches wide minimum.
    - b. 5 mil plastic.
    - c. Metallic backing at least 10 feet o.c.

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- d. 1 mil metallic foil core.
    - e. Orange in color
    - f. Suitable for buried applications.
    - g. Continuously imprinted with the words "WARNING - COMMUNICATIONS CABLE BELOW" or similar at not more than 48 inch intervals.
  - 2. Manufacturers:
    - a. Carlon Telecom Systems.
    - b. Monarch Duct & Conduit
    - c. Vikimatic
    - d. Or equal.
- B. Pull Rope
  - 1. At least 3/8 inch diameter polyethylene or 3/8" min width woven aramid fiber pulltape.
  - 2. 200 pound minimum strength.
  - 3. Manufacturers:
    - a. Arnco Dandy-Line
    - b. Carlon Telecom Systems.
    - c. Fibertek Pull-line
    - d. Monarch Duct & Conduit
    - e. Vikimatic
    - f. Any length marked tape listed elsewhere herein below constructed as a pulltape.
    - g. Or equal.
- C. Length Marked Tape
  - 1. Provide 1/2 inch flat tape with sequential markings in whole feet.
  - 2. Manufacturers:
    - a. Carlon Telecom Systems.
    - b. Greenlee
    - c. Fibertek Pulltape or Tracertape
    - d. Vikimatic
    - e. Or equal.
- D. Conduit Plugs
  - 1. Provide universal blank duct plug type, with eye for tying rope and tape.
  - 2. Manufacturers:
    - a. Carlon Telecom Systems Universal Blank Duct Plugs, Simplex, Triplex and Quadplex Duct Plugs
    - b. Condux International, Inc.
    - c. Monarch Duct & Conduit Duct Plugs and Multistep Cap Ends
    - d. GS Industries of Bassett, LLC Expandable Watertight Plugs
    - e. Or equal.
- E. Line Marker Post
  - 1. Orange polyethylene, post height 4 feet above surface.
  - 2. Soil anchor.
  - 3. Manufacturers:
    - a. Carlon Telecom Systems.
    - b. Vikimatic
    - c. Or equal.

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- F. Conduit Spacer, Trench
  - 1. Construction
    - a. Non-metallic.
    - b. Sized to snap around conduits as shown on Drawings.
    - c. Interlocking.
  - 2. Manufacturers:
    - a. Underground Devices Wunpeece.
    - b. GS Industries of Bassett, LLC Underground Products Spacer System.
    - c. Armorcast Products Company
    - d. Carlon Snap-Loc Spacers
    - e. or equal
- G. Pulling In Irons
  - 1. 7/8" Diameter
    - a. 6" exposed length minimum after embedment
    - b. RUS approved
  - 2. Manufacturer
    - a. Cooper Power Systems
    - b. Or equal by listed vault or maintenance hole manufacturer
    - c. Or equal.
- H. Cable Racks & Supports
  - 1. Construction:
    - a. 12" minimum rack arms
    - b. Snap into vertical strut sections provided with new manhole, pullboxes and vaults, or into District's existing vaults, where indicated.
  - 2. Approvals
    - a. RUS
    - b. NEMA
  - 3. Manufacturers:
    - a. Oldcastle
    - b. Underground Devices
    - c. or equal

### **PART 3 EXECUTION**

#### **3.01 GENERAL REQUIREMENTS**

- A. Refer to the most restrictive of the Code, the manufacturer's instructions, these specifications and the relevant CalTrans, NEMA or RUS guidelines and conform.

#### **3.02 CONDUIT APPLICATION**

- A. General: Install the following types of conduits and fittings in the locations listed, unless otherwise noted in the drawings:
  - 1. Underground Ductbanks, Concrete Encased
    - a. PVC
- B. Exterior, Exposed:
  - 1. Type RSC for applications up to 8 feet AFF or to first pull box, whichever is first, applications subject to physical abuse or for applications greater than 4"

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- diameter.
2. EMT acceptable in all other applications not noted above up to 4", where used in conjunction with specified Raintight (compression) couplers.
- C. Embedded in Concrete
1. RSC or rigid non-metallic conduit.
  2. PVC
- D. In Utility Tunnels
1. RSC
  2. CRSC
  3. IMC

### 3.03 UNERGROUND VAULT APPLICATION

CONDITION	ACCEPTABLE VAULT CONSTRUCTION STANDARD		
	AASHTO H-20	ANSI /SCTE 77 2007 TIER 22	PEDESTRIAN/PARKWAY ANSI /SCTE 77 2007 TIER 8
PEDESTRIAN PATHWAYS.	YES	YES	YES
AT UNPAVED ROADS SUBJECT TO INFREQUENT VEHICLE TRAFFIC.	YES	YES	NO
AT PAVED ROADS AND AT PAVED SURFACES ORDINARILY EXPOSED TO MOTOR VEHICLE TRAFFIC.	YES	NO	NO

### 3.04 UNDERGROUND CONSTRUCTION:

- A. Duct and Conduit Placement.
1. Duct lines shall have a continuous slope downward toward underground structures and away from buildings with a minimum pitch of 3 inches in 100 feet.
  2. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes.
  3. Excavate trenches along straight lines from structure to structure before ducts are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.
  4. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with ducts of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.
  5. Short-radius manufactured 90-degree duct bends may be used only for building, pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured

bend radius shall be 18 inches for ducts of less than 80 mm 3 inch diameter, and 36

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inches for ducts 80 mm 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of m 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used.

**B. Duct Bank.**

1. Duct Entrance Arrangement - Conform to Table 3.33 and applicable arrangement diagrams 3.67-3.74 of 2004 BISC Customer Owned Outside Plant Design Manual.
2. Terminate ducts in end-bells where duct lines enter underground structures.
3. Stagger duct joints by rows and layers to strengthen the duct bank.
4. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers and top spacers to provide a completely enclosed and locked-in duct bank. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of duct bank. Before pouring concrete or backfilling, as applies, anchor duct bank assemblies to prevent the assemblies from floating. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.
5. Partially Completed Duct Banks. Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, sand and dirt from entering ducts by providing suitable duct plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 1 foot apart. Restrain reinforcing assembly from moving during concrete pouring.
6. As each section of a duct line is completed from structure to structure, for duct sizes 3 inches and larger draw a flexible testing mandrel approximately 12 inches long with a diameter less than the diameter of the duct through a duct. After which, draw a stiff bristle brush having the same diameter of the duct through the duct, until duct is clear of particles of earth, sand, and gravel; then immediately install end plugs. For duct sizes less than 3 inches, draw a stiff bristle brush through the duct, until duct is clear of particles of earth, sand, and gravel; then immediately install end plugs.
7. Field cuts requiring tapers shall be made with proper tools and match factory tapers.
8. Joints shall be staggered at least 6 inches vertically. Plastic Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.
9. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape.
10. Unless otherwise noted, exterior communications duct runs shall be buried a minimum of 30" below finished grade or as required to conform to local utility requirements, whichever is greater.
11. Refer to the details in the plans for additional depth required for PDS communications duct construction.

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12. Where new trenching is required, backfill and compaction requirements shall be as defined Division 33.
  13. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.
  14. Provide concrete encasement of all communications duct runs. Construct underground duct lines of individual ducts encased in concrete. Do not mix different kinds of duct in any one duct bank. Ducts shall not be smaller than shown. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 2 inches, except separate light and power conduits from communications ducts by a minimum concrete thickness of 4 inches. The top of the concrete encasement shall not be less than 18 inches below grade except that under roads and pavement concrete be a minimum of 24 inches below grade.
    - a. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. Submit proposed bonding method for approval in accordance with the detail drawing portion of the submittals.
- C. Where duct runs under existing roads, cut and patch the pavement as indicated on the Civil Plans.
- D. Conduit Plugs and Pull Rope. New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a 3/8 inch nylon pull rope having 3 feet of slack at each end of unused or empty conduits.
- E. Manhole Placement and Connections
1. In unpaved areas, the top of new manhole covers shall be approximately 1/2 inch above the finished grade.
  2. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level.
  3. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole.
  4. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell.
  5. A cast metal grille-type sump frame and cover shall be installed over the manhole sump.
  6. Connections to Existing Manholes. For duct line connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct line encasement. Chip out the structure wall to form a key for the duct line encasement. Grout new bell end entries watertight to the formed opening.
- F. Mark locations of future provision underground raceways by pre-cast reinforced concrete pullbox set flush in ground with stamped brass disk identification plate tied to

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conduit end with "Ty-Wrap", "Quick-Wrap" or equal.

- G. In existing facilities underground construction, the Contractor shall promptly repair any indicated utility lines or systems damaged by Contractor operations. Damage to lines or systems not indicated, which are caused by Contractor operations, shall be brought to the immediate attention of the District's Representative. If the Contractor is advised in writing of the location of a non-indicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In any event, the Contractor shall immediately notify the District's Representative of any such damage.
- H. At twelve inches below grade, place specified warning tape continuously.

**END OF SECTION**

## SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. Provide all labor, materials, tools, and equipment required for permanent intelligible labeling on, or adjacent to, all cabling, connectors, innerduct, faceplates, jacks, receptacles, controls, fuses, circuit breakers, patching jacks, and racks.
- B. This section includes minimum requirements for the following:
  - 1. Labeling Communications Cabling
  - 2. Labeling Closet Hardware
  - 3. Labeling Work Stations
  - 4. Labeling Pathways, Spaces, Grounding and Bonding
- C. Refer to detailed plans for additional requirements.
- D. Clearly and distinctly indicate the function of the item.
- E. Coordinate with Record Drawings

#### 1.02 REFERENCES

- A. Usage: In accordance with Division 1.
- B. American Society for Testing and Materials (ASTM)
  - 1. ASTM D 709(2001) Laminated Thermosetting Materials
- C. Telecommunications Industry Association (ANSI/TIA)
  - 1. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure
- D. Underwriters Laboratories (UL)
  - 1. UL 969 (1995; R 2001) Marking and Labeling Systems

#### 1.03 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the applicable requirements of:
  - 1. ANSI/TIA- 606-B (2012) Administration Standard Telecommunications Infrastructure
  - 2. ANSI/TIA-569C (2012) Telecommunications Pathway and Spaces
  - 3. ANSI/TIA- 568-C (2009)Telecommunications Cabling Standard.
  - 4. BICSI Telecommunications Distribution Methods Manual.
  - 5. UL 969.

#### 1.04 SUBMITTALS

- A. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Procedures: In accordance with Division 1

#### 1.06 SEQUENCING

- A. Not Used.

### PART 2 PRODUCTS

#### Identification For Communications Systems - 270553

**201 COMMUNICATION CABLING LABELS, INTERIOR**

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
- C. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow - so that the labels are easily distinguishable.
- D. Shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.
- E. Shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.
- F. Manufacturers:
  - 1. Cable Type - Silver Satin
    - a. Brady TLS2200 labels - PTL-31-427, PTL-32-427
    - b. Brady Laser tab labels - LAT-18-361, LAT-53-361
    - c. Hubbell
    - d. Leviton
    - e. Panduit.
    - f. or equal.
  - 2. Cable Type - 4 pair UTP
    - a. Brady TLS2200 labels - PTL-31-427, PTL-32-427
    - b. Brady Laser tab labels - LAT-18-361, LAT-53-361
    - c. Hubbell
    - d. Leviton
    - e. Panduit.
    - f. or equal.
  - 3. Cable Type - 4 pair STP
    - a. Brady TLS2200 labels - PTL-21-427
    - b. Brady Laser tab labels - LAT-19-361
    - c. Hubbell
    - d. Leviton
    - e. Panduit.
    - f. or equal.
  - 4. Cable Type - 25 pair copper
    - a. Brady TLS2200 labels - PTL-21-427
    - b. Brady Laser tab labels - LAT-19-361
    - c. Panduit.
    - d. or equal.
  - 5. Cable Type - 50 pair copper
    - a. Brady TLS2200 labels - PTL-33-427
    - b. Panduit.
    - c. or equal.
  - 6. Cable Type - 100 pair copper
    - a. Brady TLS2200 labels - PTL-34-427
    - b. Brady
    - c. Panduit.

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- d. or equal.
- 7. Cable Type - 2 strand fiber
  - a. Brady TLS2200 labels - PTL-19-427
  - b. Brady Laser tab labels - LAT-17-361
  - c. Panduit.
  - d. or equal.
- 8. Cable Type - 4-12 strand fiber
  - a. Brady TLS2200 labels - PTL-21-427
  - b. Brady Laser tab labels - LAT-19-361
  - c. Panduit.
  - d. or equal.
- 9. Cable Type - RG-6 Coax
  - a. Brady TLS2200 labels - PTL-31-427, PTL-32-427
  - b. Brady Laser tab labels - LAT-18-361, LAT-53-361
  - c. Panduit.
  - d. or equal.
- 10. Cable Type - RG-59 Coax
  - a. Brady TLS2200 labels - PTL-31-427, PTL-32-427
  - b. Brady Laser tab labels - LAT-18-361, LAT-53-361
  - c. Panduit.
  - d. or equal.
- 11. Cable Bundles
  - a. Brady TLS2200 labels - PTL-12-109
  - b. Panduit.
  - c. or equal.

### **202 COMMUNICATIONS CABLE LABELS, OUTSIDE PLANT**

- A. Cable Tags in Manholes, Handholes, and Vaults
  - 1. Provide tags for communications cable or wire located in manholes, handholes, and vaults.
    - a. The tags shall be polyethylene.
    - b. Machine printed - Do not provide handwritten letters.
  - 2. Polyethylene Cable Tags
    - a. Provide tags of polyethylene that have an average tensile strength of 22.4 MPa (3250 pounds per square inch) 3250 pounds per square inch; and that are two millimeter (0.08 inch) 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 77 degrees C 170 degrees F.
    - b. Provide 1.3 mm (0.05 inch) 0.05 inch (minimum) thick black polyethylene tag holder.
    - c. Provide a one-piece nylon, self-locking tie at each end of the cable tag.
    - d. Ties shall have a minimum loop tensile strength of 778.75 N (175 pounds) 175 pounds. The cable tags shall have black block letters, numbers, and symbols 25 mm (one inch) one inch high on a yellow background.
    - e. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.
  - 3. Manufacturers:
    - a. Panduit

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- b. Brady
- c. or equal.

### **203 CLOSET HARDWARE LABELS**

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
- C. Where insert type labels are used provide clear plastic cover over label.
- D. Manufacturer:
  - 1. Copper Patch Panels
    - a. 4 port group
      - 1) Brady Laser tab labels - 2.8" x 0.375" (71.12mm x 9.52mm), LAT-43-707
      - 2) Hubbell XPLPPA series
      - 3) Leviton
      - 4) Panduit.
      - 5) or equal.
    - b. 6 port group
      - 1) Brady Laser tab labels - 3.6" x 0.375" (91.44mm x 9.52mm), LAT-44-707
      - 2) Hubbell
      - 3) Leviton
      - 4) Panduit.
      - 5) or equal.
    - c. Individual port
      - 1) Brady
        - (a) TLS2200 labels - 0.5" x 0.375" (12.70mm x 9.52mm) white, PTL-44-422
        - (b) Laser tab labels - 0.5" x 0.375" (12.70mm x 9.52mm) white, LAT-45-707
        - (c) TLS2200 labels - 0.5" x 0.375" (12.70mm x 9.52mm) clear, PTL-44-430
        - (d) Laser tab labels - 0.5" x 0.375" (12.70mm x 9.52mm) clear, LAT-45-712
        - (e) TLS2200 labels - 0.5" x 0.5" (12.70mm x 12.70mm) white, PTL-7-422
        - (f) Laser tab labels - 0.5" x 0.5" (12.70mm x 12.70mm) white, LAT-46-707
        - (g) TLS2200 labels - 0.5" x 0.5" (12.70mm x 12.70mm) clear, PTL-7-430
        - (h) Laser tab labels - 0.5" x 0.5" (12.70mm x 12.70mm) clear, LAT-46-712
      - 2) Hubbell
      - 3) Leviton
      - 4) Panduit.
      - 5) or equal
    - d. Patch Panel Name Label.
      - 1) Hubbell XOLPPID Series
      - 2) Brady
      - 3) Leviton
      - 4) Panduit
      - 5) or equal.
  - 2. Non-keystone based fiber patch panels
    - a. Hubbell XPLFOSEPAW

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- b. Brady
  - c. Leviton
  - d. Panduit
  - e. as provided with Patch Panel by the manufacturer
  - f. or equal.
3. 110 blocks
- a. Brady Laser tab labels - 7.9" x 0.475" (200.6mm x 12.07mm), LAT-177-124
  - b. Hubbell XPL110 series.
  - c. Leviton
  - d. Panduit.
  - e. or equal.

### **204 GROUNDING AND BONDING, PATHWAY, AND SPACE LABELS**

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
- C. Manufacturers:
  - 1. Brady Corporation
    - a. TLS2200 labels
      - 1) PTL-20-422, Size 2.0" x 1.0" (50.80mm x 25.40mm)
      - 2) PTL-22-422, Size 3.0" x 1.0" (76.20mm x 25.40mm)
      - 3) PTL-37-422, Size 3.0" x 1.9" (76.20mm x 48.26mm)
      - 4) PTL-23-422, Size 4.0" x 1.0" (101.60mm x 25.4mm)
      - 5) PTL-38-422, Size 4.0" x 1.0" (101.60mm x 25.4mm)
    - b. Laser tab labels
      - 1) LAT-13-747, Size 1.875" x 0.833" (47.63mm x 21.16mm)
      - 2) LAT-24-747, Size 1.75" x 1.0" (44.45mm x 25.40mm)
      - 3) LAT-32-747, Size 3.0" x 0.9 " (76.20mm x 22.86mm)
      - 4) LAT-33-747, Size 2.0" x 1.437" (50.80mm x 36.50mm)
      - 5) LAT-34-747, Size 3.0" x 1.437" (76.20mm x 36.50mm)
    - c. Continuous tape for TLS2200
      - 1) PTL-8-422, Size 0.5" (12.70mm) white polyester
      - 2) PTL-8-430, Size 0.5" (12.70mm) clear polyester
      - 3) PTL-8-439, Size 0.5" (12.70mm) white vinyl
      - 4) PTL-42-439, Size 1.0" (25.4mm) white vinyl
      - 5) PTL-43-439, Size 1.9" (48.26mm) white vinyl
  - 2. Panduit.
  - 3. or equal.

### **205 WORKSTATION LABELS**

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
- C. Where insert type labels are used provide clear plastic cover over label.
- D. Manufacturers:
  - 1. Brady Corporation
    - a. Desi-strip inserts
      - 1) TLS2200 labels -1.9"x0.375"(48.26mmx9.52mm) white, PLT-40-412

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- 2) Laser tab labels -1.9"x0.375"(48.26mmx9.52mm) white, LAT-176-124
  - b. Location ID
    - 1) TLS2200 labels - 1.0" x 0.375" (25.40mm x 9.52mm) white, PTL-16-422
    - 2) Laser tab labels -1.0" x 0.375" (25.40mm x 9.52mm) white, LAT-47-707 3) TLS2200 labels- 1.0" x 0.375" (25.40mm x 9.52mm) clear, PTL-16-430
    - 4) Laser tab labels -1.0" x 0.375" (25.40mm x 9.52mm) clear, LAT-8-712 5) TLS2200 labels- 1.0" x 0.5" (25.40mmx 12.70mm) white, PTL-17-422
    - 6) Laser tab labels -1.0" x 0.5" (25.40mm x 12.70mm) white, LAT-7-707 7) TLS2200 labels- 1.0" x 0.5" (25.40mm x 12.70mm) clear, PTL-17-430
    - 8) Laser tab labels- 1.0" x 0.5" (25.40mm x 12.70mm) clear, LAT-7-712
    - 9) TLS2200 labels- 1.5" x 0.375" (38.10mm x 9.52mm) white, PTL-45-422 10) Laser tab labels- 1.5" x 0.375" (38.10mm x 9.52mm) white, LAT-47-707 11) TLS2200 labels- 1.5" x 0.375" (38.10mm x 9.52mm) clear, PTL-45-430 12) Laser tab labels-1.5" x 0.375" (38.10mm x 9.52mm) clear, LAT-47-712 13) TLS2200 labels- 1.5" x 0.5" (38.10mm x 12.70mm) white, PTL-29-422
    - 14) Laser tab labels- 1.5" x 0.5" (38.10mm x 12.70mm) white, LAT-47-707 15) TLS2200 labels- 1.5" x 0.5" (38.10mm x 12.70mm) clear, PTL-29-430
    - 16) Laser tab labels-1.5" x 0.5" (38.10mm x 12.70mm) clear, LAT-47-712
  - c. Outlet/Jack ID
    - 1) TLS2200 labels -0.5" x 0.375" (12.70mm x 9.52mm) white, PTL-44-422
    - 2) Laser tab labels - 0.5" x 0.375" (12.70mm x 9.52mm) white, LAT-45-707 3) TLS2200 labels - 0.5" x 0.375" (12.70mmx 9.52mm) clear, PTL-44-430
    - 4) Laser tab labels -0.5" x 0.375" (12.70mmx 9.52mm) clear, LAT-45-712 5) TLS2200 labels - 0.5" x 0.5" (12.70mm x 12.70mm) white, PTL-7-422
    - 6) Laser tab labels- 0.5" x 0.5" (12.70mm x 12.70mm) white, LAT-46-707 7) TLS2200 labels - 0.5" x 0.5" (12.70mm x 12.70mm) clear, PTL-7-430
    - 8) Laser tab labels - 0.5" x 0.5" (12.70mm x 12.70mm) clear, LAT-46-712
  - d. General Use Labels
    - 1) TLS2200 labels - 0.375" (9.52mm) cont. white, PTL-46-422 2) TLS2200 labels - 0.375" (9.52mm) cont. clear, PTL-46-430
2. Hubbell
- a. Location ID
    - 1) Desi-Strip Style
      - (a) XPLFP10W
    - 2) Adhesive
      - (a) XPLFPA10W, XPLFPA10W,
  - b. Outlet/Jack ID
    - 1) XPLIPA10W, XPLIPA10C

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3. Leviton
4. Panduit.
5. or equal.

## **206 NAMEPLATES**

- A. Field Fabricated Nameplates
  1. Features/Function/Construction
    - a. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.
    - b. Comply with ASTM D 709.
    - c. Each nameplate inscription shall identify the function and, when applicable, the position.
    - d. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core.
    - e. Surface shall be matte finish.
    - f. Corners shall be square.
    - g. Accurately align lettering and engrave into the core.
    - h. Minimum size of nameplates shall be one by 2.5 inches.
    - i. Lettering shall be a minimum of 0.25 inch high normal block style

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. Apply labeling to clean surfaces free of oil, dust, solvents or loose material.
- B. Apply after Project painting in area of application is complete.
- C. All labels shall be machine/prINTER created labels.
- D. Apply to locations where labeling will not be damaged, covered over or in the way of the ordinary maintenance and operation of the installed communications infrastructure or system.
- E. Apply labeling right side up, parallel to major edges of surfaces to which it is applied. When no line is evident, apply parallel to floor line. Correct conditions of labeling applied out of true.
- F. Protect installed labeling from damage.
- G. Replace labeling that is defaced, illegible or peeling off of the surface to which it is applied.

### **3.02 WORKSTATION JACK, CABLE AND PATCH PANEL ASSIGNED CIRCUIT NUMBERS**

- A. Label General: WAO jack assignment number and patch panel port number shall be the same number.
- B. Station cable numbers shall be in the following format
  1. XXX.YYY.PZZ, where:
    - a. XXX = IDF Number/MDF
    - b. YYY = Room Number
    - c. PZZ = Port Number:
  2. Example 1: Port 5 in Room 106 connected to the MDF == MDF.106.P05
  3. Example 2: Port 2 in Room 212 connected to IDF 6 == 6.212.P02
- C. The cover plate area directly above and beneath the jacks are the labeling areas. In the top area, using the specified means, label the faceplate number assigned on the contract documents.



### **303 IDENTIFICATION & LABELING**

- A. Pathways
  - 1. Pathways shall be marked at each endpoint and at all intermediate pull or junction boxes. In the case of partitioned pathways (i.e. innerduct) each partition shall have a unique identifier.
  - 2. Label pathways using the appropriate abbreviation and a number.
  - 3. Use adhesive type labels.
- B. Labels shall be affixed at the entry to all telecommunications rooms and spaces (Includes entrance facilities, communication equipment rooms, communication equipment spaces and work areas)
  - 1. Use adhesive type labels for all communications space labeling,
  - 2. Affix labels to entrance doors - coordinate location with District's Representative.
- C. Cables
  - 1. Horizontal and Indoor Backbone Cables shall be marked within 12" of each endpoint or to innerduct in which the cable is installed.
  - 2. Except where installed in innerduct or conduit, all backbone fiber optic cable shall have affixed to the outer jacket, labels of a bright color that contain at least the legend "FIBER OPTIC CABLE." These labels must be affixed at separations no greater than 50 ft.
  - 3. Within every manhole/vault/pullbox and within 4 ft of the entrance into a building every backbone cable's assigned identifier shall be affixed to either the cable's outer jacket or to innerduct in which the cable is installed.
  - 4. Any cable installed in conduit shall be labeled at all intermediate pull or junction boxes.
  - 5. Label cables using the appropriate circuit ID.
  - 6. Use adhesive type labels for all communications cable labels.
  - 7. Affix labels to cables - marking cable is not permitted.
  - 8. Where cable is fully encased in innerduct label the outside of the innerduct with the cable label and, where the contents are fiber optic cabling, the "FIBER OPTIC CABLE" label.
- D. 110 blocks
  - 1. Each cable termination position on 110 blocks shall be labeled with number designators.
    - a. All backbone copper cable termination blocks shall be labeled with both the pair count of every 5th pair and the cable's assigned identifier.
  - 2. Where insert type labels are used install clear plastic cover over reprinted or Laser printed type label. Install five (5) pair and four (4) pair 110 I.D. strips for backbone cabling.
    - a. District's Representative to provide District generated cable number.
  - 3. Pair call-out labeling: Pair call-out labeling shall designate every fifth (5th) pair consecutively through total pair count of the cable terminated on the block but not including the first (1st) and twenty-fifth (25th) pairs of each twenty-five (25) pair field bundle: Example for fifty (50) pair cable -- 5, 10, 15, 20, 30, 35, 40, 45.
- E. Backbone Fiber Patch Panel Labeling
  - 1. Each backbone fiber patch panel shall have a header label.
    - a. Header Label format and content shall be as follows:
      - 1) DISTRICT generated cable number.

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- 2) 'From' District building Telecommunication Room (TR) number for ISP riser or 'From' District building number for OSP cable.
    - 3) Fiber strand type designation and strand count. SM (single mode) XX; MM (multi-mode) XX where XX = strand count. If cable is a hybrid make sure both strand type counts are accounted for in header label.
  - b. District's Representative to provide District generated cable number.
  - c. Fiber Patch Panel Port Labeling: Label each fiber patch panel port with the strand count terminated on the port. Example for a duplex port termination: 5-6 = strand 5 and strand 6 of cable are terminated on this fiber patch panel port. Simplex port termination 6 = strand 6 is of cable is terminated on this fiber patch panel port.
  - d. All labels shall be printed labels. Hand labeling is not acceptable unless approved in writing as acceptable by the PP&C project manager or his/her designate.
- F. Voice Cross-Connect System Labeling
  1. The 110-Blocks shall be labeled "Voice Cross-Connect to Rack #\_ Panel # ". Each cable shall be numbered from 1-48 on the 110-block Designation Strips.
  2. The patch panels on the racks shall be labeled "Voice Cross-Connect Rack #\_ Panel # ". Each jack shall be numbered from 1-48 on each panel.
- G. Workstations
  1. All faceplate labels shall indicate the faceplate number and the circuit ID for each cable that it houses
  2. For faceplates where insert type labels are used install clear plastic cover over preprinted or Laser printed type label.
  3. For faceplates without insert type labels use adhesive type labels affix labels to faceplate - marking faceplates is not permitted.
  4. Patch cords installed under the work of this Project shall be labeled at each endpoint using the appropriate circuit ID.
  5. Use adhesive type labels for all communications cable labels.
  6. Affix labels to cables - marking cable is not permitted.
- H. Grounding and Bonding
  1. The TMGB(s) (telecommunications main ground bar) shall be labeled as such with an adhesive type label(s) affix label(s) to TMGB.
  2. The conductor connecting the TMGB (telecommunications main ground bar) to the building ground shall be labeled at each end with an affixed label in a visible location as close as practicable to the bonding point at each end of the conductor.
- I. Firestopping
  1. Each firestopping location shall be labeled at each location where firestopping is installed, on each side of the penetrated fire barrier, within 300 mm (12 in.) of the firestopping material.

### END OF SECTION

### Identification For Communications Systems - 270553

## **SECTION 271000 - STRUCTURED CABLING, BASIC MATERIALS & METHODS**

### **PART 1 GENERAL**

#### **1.01 SCOPE OF WORK**

- A. This Section defines common means and methods for the work of the following Sections:
  - 1. Section 27 11 13 - Communications Entrance Protection
  - 2. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
  - 3. Section 27 11 19 - Communications Termination Blocks and Patch Panels
  - 4. Section 27 11 23 - Communications Cable Management
  - 5. Section 27 13 00 - Communications Interior Backbone Cabling
  - 6. Section 27 14 00 - Communications Outside Plant Backbone Cabling
  - 7. Section 27 15 00 - Communications Horizontal Cabling

#### **1.02 RELATED DOCUMENTS**

- A. Section 27 05 00 - Common Work Results for Communications applies to the work of this Section.

#### **1.03 REFERENCES**

- A. Usage: In accordance with Division 1.
- B. In Addition to the requirements of Section 27 05 00 - Common Work Results for Communications, conform to the applicable portions of the following standards agencies:
  - 1. American Society For Testing and Materials (ASTM)
    - a. ASTM A228/A228M-02 Steel Wire, Music Spring Quality.
  - 2. Bellcore
    - a. TR-NWT-000253 Intermediate Reach, 1, OC3
  - 3. Federal Communications Commission (FCC)
    - a. The Code of Federal Regulations, Title 47, Telecommunications, Chapter 1 - FCC Part 68 (1982 issue or latest revision) (47 CFR 68) .
  - 4. Institute of Electrical and Electronic Engineers
    - a. IEEE 383-2003 Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations
    - b. IEEE 100-00 The Authoritative Dictionary of IEEE Standards Terms
  - 5. Insulated Cable Engineers Association (ICEA)
    - a. ICEA S-56-434 (1983, 5th Ed.) Reaffirmed October 18, 1991 Polyolefin Insulated Communication Cables for Outdoor Use.
    - b. ANSI/ICEA S-83-596-2011 Indoor Optical Fiber Cables
    - c. ANSI/ICEA S-84-608-2010 Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor
    - d. ANSI/ICEA S-86-634-2011 Buried Distribution & Service Wire, Filled Polyolefin Insulated, Copper Conductor.
    - e. ANSI/ICEA S-87-640-2011 Fiber Optic Outside Plant Communications Cable
    - f. ICEA S-102-700-2004 - ICEA Standard For Category 6 Individually Unshielded Twisted Pair Indoor Cables (With Or Without An Overall Shield) For Use In Communications Wiring Systems Technical Requirements

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- g. ICEA S-103-701-2011 Riser Cables Technical Requirements
- 6. National Electrical Manufacturers Association (NEMA)
  - a. NEMA WC 63.1(2000) Twisted Pair Premise Voice and Data Communications Cables
- 7. National Fire Protection Association (NFPA)
  - a. NFPA 70 National Electrical Code
- 8. Telecommunications Industry Association (ANSI/TIA)
  - a. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises
  - b. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
  - c. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
  - d. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, including errata issued in October, 2008.
  - e. ANSI/TIA 569-C (2012) Telecommunications Pathways and Spaces
  - f. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure
  - g. ANSI- J-STD-607-B (2011) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- 9. Underwriters Laboratories, Inc. (UL)
  - a. UL 444(2002; Bul. 2002, 2003) Communications Cables
  - b. UL 910(1998) Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
  - c. UL 1286(1999; R 2004) Office Furnishings
  - d. UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords. Oct. 2001
  - e. UL 1666(2000; R 2002) Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
  - f. UL 1863(2000; R 2004) Communications Circuit Accessories

### 1.04 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in
  - 1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
  - 2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
  - 3. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
  - 4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, plus errata issued in October, 2008.
  - 5. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure
  - 6. IEEE Std 100 and
  - 7. Section 27 05 00
  - 8. As defined in this Section.

### 1.05 SUBMITTALS

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

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**1.06 DELIVERY, STORAGE AND HANDLING**

- A. Comply with requirements of Division 1, Section 27 05 00 - Common Work Results for Communications and the following:
- B. Shipping Conditions:
  - 1. All cable shall be shipped on reels or manufacturer supplied "handy boxes".
  - 2. The diameter of the drum shall be at least 13 times the diameter of the cable.
  - 3. The reels shall be substantial and so constructed as to prevent damage during shipment and handling.
  - 4. Secure the outer end of the cable to the reel head so as to prevent the cable from becoming loose in transit.
  - 5. Project the inner end of the cable into a slot in the side of the reel, or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.
  - 6. The inner end shall be fastened so as to prevent the cable from becoming loose during installation. End seals shall be applied to each of the cables to prevent moisture from entering the cable.
- C. Storage:
  - 1. Do not roll or store cable reels without an appropriate underlay.
  - 2. Retain factory cable protection until installation. Supplement with heavy gauge plastic sheeting if factory protective membrane is pierced prior to installation. Tape ends and seams water and dust tight.
  - 3. The reels with cable shall be suitable for outside storage conditions when the temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent.
  - 4. Protect cable reels from physical damage from site construction vehicles or from settling into the soil.
  - 5. Equipment, other than outside plant rated cable protected with fully watertight cable caps, to be delivered and placed in storage, suitably protected from the weather, humidity and temperature variation, dirt and dust, or other contaminants.
- D. Handling
  - 1. Cabling other than outside plant cabling exposed to standing water or other liquids at any time during storage, delivery or placement shall be replaced at no expense to the District.
  - 2. Cut ends of outside plant rated cabling or portions of outside plant rated cable with a damaged jacket shall not be exposed to standing water or other liquids at any time during storage, delivery or placement. Where such conditions occur, the District's representative may require that the cable be replaced at no cost to the District.

**1.07 SEQUENCING**

- A. Not Used.

**1.08 PERFORMANCE STANDARDS**

- A. Telephone (Voice) Copper Cabling Plant:
  - 1. Suitable for direct connection to the Public Switched Network in accordance with rules set forth by FCC Part 68, California Public Utilities Commission, and other Authorities Having Jurisdiction.
  - 2. Includes Category 5e outside plant cabling (UTP5e-4OP) used as low pair count

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outside plant voice cabling.

**B. Horizontal (Station) Category 6 Copper Cabling - Permanent Link**

1. Testing shall commence while the District's equipment in the area of service is operational and creating worst case emissions associated with its operation while in good working order. Every effort shall be made to include worst case influence on the materials install shall be taken.
2. In accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard", every horizontal Cat6 station cabling link in the project shall be tested for:
  - a. Wire Map
  - b. Length
  - c. Insertion Loss
  - d. NEXT Loss
  - e. PS NEXT Loss
  - f. ACR-F Loss
  - g. PS ACR-F Loss
  - h. Return Loss
  - i. Propagation Delay
  - j. Delay Skew
3. Using the listed Category 6 cable test set, test installed cabling using Permanent Link procedure and submit report demonstrating that the link meets the following parameters:

FREQUENCY (MHZ)	INSERTION LOSS	NEXT (WORST PAIR TO PAIR)	POWER SUM NEXT	ELFEXT (WORST PAIR TO PAIR)	POWER SUM ELFEXT	RETURN LOSS
1.0	2.0	79.3	77.3	72.8	69.8	20.0
4.0	3.8	70.3	68.3	60.7	57.7	23.6
10.0	5.9	64.3	62.3	52.8	49.8	26.0
16.0	7.5	61.3	59.3	48.7	45.7	26.0
20.0	8.4	59.8	57.8	46.7	43.7	26.0
31.3	10.6	56.9	54.9	42.9	39.9	25.0
62.5	15.3	52.4	50.4	36.8	33.8	23.5
100.0	19.7	49.3	47.3	32.8	29.8	22.5
150.0	24.7	48.7	44.7	29.3	26.3	21.6
200.0	29	44.8	42.8	26.8	23.8	21.0
250.0	32.6	43.3	41.3	24.8	21.8	20.5

- A. Each permanent link shall demonstrate a positive PSACR beyond 350 MHz to meet and exceed the bandwidth requirements of TIA-568-C.2 Category 6 standards. Each permanent link shall demonstrate 2 dB of cross talk headroom over TIA-568-C.2 Category 6 standard for NEXT, PSNEXT, ELFEXT and PSELFEXT bit error rate.
  1. Report whether tested link passes or fails

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2. Note exceptions to required Category standards. Remedy and retest
- B. Category 6A Station Cabling Performance Testing
1. General Requirements
    - a. In accordance with the field test specifications defined in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard” (TIA Cat 6A Standard), every Cat 6A cabling link in the installation shall be tested for:
      - b. Wire Map
      - c. Length
      - d. Insertion Loss
      - e. NEXT Loss
      - f. PS NEXT Loss
      - g. ACR-F Loss
      - h. PS ACR-F Loss
      - i. Return Loss
      - j. Propagation Delay
      - k. Delay Skew
  2. In addition to testing the “In-link” performance parameters specified above, Alien Crosstalk testing or “Between-link” testing shall be carried out in accordance with Section 4.7 of ANSI/TIA-1152. Alien crosstalk testing includes the PS ANEXT and PS AACR-F (Power sum alien attenuation-to-crosstalk ratio from the far end) performance parameters. The standards refer to the link-under-test for Alien Crosstalk as the disturbed link.
  3. PS ANEXT and PS AACR-F shall meet or exceed the limits defined in Section 6 of the TIA Cat 6A Standard.
    - a. Selection of disturbed links: 1 % of the links in the cabling installation or 5 links, whichever is more. Chose short, medium and long links equally.
    - b. Selection of disturber links. Select all of the links that are in the same cable bundle and the most consistently positioned relative to the disturbed link as disturbing links.
  4. If the margin of PS ANEXT and PS AACR-F exceeds 5 dB for the first three short, medium and long links (nine in total), further alien crosstalk testing can be discontinued.
  5. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the “Permanent Link” performance specification as defined in the TIA Cat 6A Standard.
  6. One hundred percent of the installed cabling links must pass the requirements of the standards mentioned in above and as further detailed below. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result  
of the tests for all links shall be provided in the test results documentation in accordance Section 27 05 00.
  7. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs

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- provided by BICSI or the ACP (Association of Cabling Professionals).
8. The test equipment (tester) shall comply with the accuracy requirements for Level IIIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 4 of ANSI/TIA-1152.
  9. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
  10. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
  11. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
  12. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail or Fail\* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass\*.
  13. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent '\*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.
  14. The District's Representative will select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored as specified herein above. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.
  15. Performance Test Parameters.
    - a. The test parameters for Cat 6A are defined in the TIA Cat 6A standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 500 MHz) must meet or exceed the limit value determined in the above-mentioned standard.
      - 1) Wire Map. Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.
      - 2) Length. The field tester shall be capable of measuring length of all pairs of

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a basic link or channel based on the propagation delay measurement and the average value for Nominal Velocity of Propagation (NVP). The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for

the Permanent Link configuration (90 meters - 295 feet) plus 10% to allow for the variation and uncertainty of NVP.

- 3) Insertion Loss (Attenuation). Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz through 500 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.
- 4) NEXT Loss. Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 500 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the standard as shown in Table 1. . Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

<b>Maximum frequency step size as defined in ANSI/TIA-1152</b>	
<b>Frequency Range (MHz)</b>	<b>Maximum Step size (MHz)</b>
1 – 31.25	0.15
31.26 – 100	0.25
100 – 250	0.50
250 – 500	1.00

- 5) PS NEXT Loss. Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 500 MHz and

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the step size may not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

- 6) ACR-F, pair-to-pair. Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured from 1 through 500 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard as in Table 1. Minimum test results

documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

- 7) PS ACR-F Loss. Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
- 8) Return Loss. Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
- 9) Propagation Delay. Propagation delay is the time required for the signal to travel from one of the link to the other. This measurement is to be

performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

- 10) Delay Skew [as defined in the TIA Cat 6A Standard; Section 6.2.19] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.
- 11) PS ANEXT. Pair-to-pair Alien NEXT (ANEXT) contributions is measured by applying the stimulus signal at the near end to one wire pair of a disturbing link and measuring the coupled signal at the near end of a wire pair in a disturbed link. This process is repeated for every wire pair in a disturbing link. The PS ANEXT for each wire pair in a disturbed link is obtained by the power sum addition of all the pair-to-pair ANEXT results to that wire pair from all wire pairs in disturbing links. All the links that are bundles with the disturbed link need to be included as disturbing links. In addition, links that are terminated in adjacent positions in a patch panel or interconnect panel should also be included as disturbing links in this test.
  - (a) Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS ANEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
- 12) PS AACR-F. The pair-to-pair Alien Far End crosstalk (AFEXT) contributions is measured by applying the signal at the near end to one wire pair of a disturbing channel or permanent link and measuring the coupled signal at the far end of a wire pair in a disturbed channel or permanent link. This process is repeated for every wire pair in a disturbing link and for all links in close proximity. A normalization, which is dependent on the relative length of disturbing and disturbed link, is applied to each pair-to-pair alien FEXT measurement. Then the PS Alien Attenuation-to-Crosstalk Ratio from the Far end (PS AACR-F) for each wire pair in a disturbed channel or permanent link is obtained by the power sum addition of all the normalized pair-to-pair far end alien crosstalk results to that wire pair from all wire pairs in disturbing links in close proximity.
  - (a) Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS AACR-F. If the link or channel connects two patch panels (data center), these wire pairs must be identified for the tests performed from both ends. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

- b. Test Result Documentation
  - 1) The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
  - 2) The database for the completed job shall be stored and delivered on CD-ROM or DVD or equivalent media selected by the District’s Representative, including the software tools required to view, inspect, and print any selection of test reports.
  - 3) A PDF copy of the test results shall be provided that lists all the links that have been tested with the following summary information
    - (a) The identification of the link in accordance with the naming convention defined in the overall system documentation
    - (b) The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
    - (c) The date and time the test results were saved in the memory of the tester.
- c. General Information to be provided in the electronic data base with the test results information for each link:
  - 1) The identification of the customer site as specified by the end-user
  - 2) The identification of the link in accordance with the naming convention defined in the overall system documentation
  - 3) The overall Pass/Fail evaluation of the link-under-test
  - 4) The name of the standard selected to execute the stored test results
  - 5) The cable type and the value of NVP used for length calculations
  - 6) The date and time the test results were saved in the memory of the tester
  - 7) The brand name, model and serial number of the tester
  - 8) The identification of the tester interface
  - 9) The revision of the tester software and the revision of the test standards database in the tester
- d. In-link (In-Channel) detailed test results. The detailed test results data to be provided in the electronic database for must contain the following information:
  - 1) For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
  - 2) Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m and the test limit value
  - 3) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
  - 4) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value

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- 5) Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair
  - 6) Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
  - 7) NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link
  - 8) PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link
- e. Between-Link (Between-Channel) Test Results Data. A test report shall be provided for each disturbed link included in the Alien Crosstalk sample test. This test report must contain
- 1) PS ANEXT results at each frequency for each wire pair in a victim link as well as the PS ANEXT results for the average of these four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS ANEXT shall be measured and tested from the end of the link or channel where all cables are terminated at a distribution panel. In case the cabling runs from panel to panel (data center) where the worst case PS ANEXT margin is less than 2 dB, the PS ANEXT test results for each disturbed link shall be collected and saved from both ends (both panels) of the disturbed link.
  - 2) PS AACR-F results at each frequency tested for each wire pair in a disturbed link as well as the PS AACR-F results for the average of the four wire pairs. The worst case margin and the worst values shall be provided for each wire pair and the average of the four wire pairs. PS AACR-F only needs to be measured and tested from one end of the link or channel.
- C. Fiber Optic Cabling - as specified herein below.

## **1.09 TESTING**

### **A. General**

1. In addition to the tests detailed in this specification section, the contractor shall notify the District's Representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge
2. Test and report on each intermediate cabling segment separately, including station cabling, horizontal distribution (each segment, if multiple) and telecommunications room wiring.
3. Test each end to end cable link.
4. Submit machine-generated documentation and raw data of all test results on Contractor-provided, and District's Representative approved, forms; and in electronic format approved by the District's Representative.
5. Provide machine-generated data on an appropriate disk media (CD-ROM CD-R format) to be transferred to the District's computers.
  - a. Where the machine-generated documentation requires use of a proprietary computer program to view the data, provide the District with 1 licensed copy of the software.
6. Provide registered testing software used for the actual tests to the District for review

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of test data.

**B. Test Equipment:**

1. Provide in conformance with the applicable requirements of 27 05 00 - Common Work Results for Communications.
2. Test systems using at least one (1) each of the following test measurement devices or their functional equivalents:
  - a. IEC Level V field tester: Fluke DSX-5000, Agilent or equal.
    - 1) The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
    - 2) The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction..
  - b. Outside Plant Voice Cabling Plant tester - capable of detecting shorts, opens, reversals, mis-wiring and crosstwists. (Siemon STM-8, Fluke or equal).
  - c. Tone Test Sets.
  - d. Optical Power Meter (Corning Cable Systems, Fluke DTX-1800 or equal)
    - 1) Power measurement uncertainty of  $\pm 0.25$  dB.
    - 2) Store reference power measurement.
    - 3) Save at least 100 results in internal memory.
    - 4) PC interface (serial or USB).
    - 5) Minimum Performance - Single Mode Power Meter
      - (a) 1300nm and 1500nm ( $\pm 20$  nm) wavelength dual laser light sources.
      - (b) Output power of -10 dBm minimum
      - (c) Output Stability  $\pm 0.40$  dB from 0 to 50 degrees C
      - (d) Long Term output stability  $\pm 0.10$ dB at 25 degrees C
      - (e) Measurement range shall be from 10 to -60 dBm
      - (f) Accuracy shall be  $\pm 5\%$  at 0 to -50dBm and  $\pm 10\%$  10 to 0dBm and -50 to -60 dBm.
      - (g) Resolution shall be 0.1 dB
      - (h) Connector types shall include: LC, ST, SC.
  - e. Optical Time Domain Reflectometer. (Fluke, JDSU or equal).
    - 1) Singlemode OTDR
      - (a) Wavelengths of 1310 nm ( $\pm 20$  nm) and 1550 nm ( $\pm 20$  nm).
      - (b) Event deadzones of 3.5 m maximum at 1310 nm and 1550 nm.
      - (c) Attenuation deadzones of 10 m maximum at 1310 nm and 12 m maximum at 1550 nm.
      - (d) Distance range not less than 10000 m.
      - (e) Dynamic range at least 10 dB at 1310 nm and 1550 nm

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- f. Site portable communications systems (walkie-talkie, cell phone or similar).
  - g. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.
- C. Station Wiring, General
  - 1. Test station wire only after all pairs of station wire in a work area have been terminated at both ends, and no work of this Section or other Sections may cause physical disturbance to the wiring.
  - 2. Correct any and all transpositions found. Retest.
  - 3. If any conductor in a station wire tests either open or short, then the entire station wire is to be removed, replaced, and re-tested.
- D. Category 6 Cabling.
  - 1. Using the listed Category 6 cable test set, test and submit report on the parameters specified for Category 6 cabling in this Section. Report whether tested link passes or fails the Category 6 standards. Cables must pass TIA Permanent Link Certification for the cable type being installed. A "Marginal" test result will not be accepted.
  - 2. Note exceptions to required Category standards. Remedy and retest.
- E. Category 6A Cabling.
  - 1. Using the listed Category 6A cable test set, test and submit report on the parameters specified for Category 6A cabling in this Section. Report whether tested link passes or fails the Category 6A standards. Cables must pass TIA Permanent Link Certification for the cable type being installed. A "Marginal" test result will not be accepted.
  - 2. Note exceptions to required Category standards. Remedy and retest.
- F. Telephone: Outside Plant, Inside Riser Wire:
  - 1. General:
    - a. A new cable shall be tested only after all wires within the cable have been terminated at both ends.
    - b. For unshielded cable, "measurements to ground" means an electrical connection to the Telecommunications Ground Bus, building steel, electrical metallic conduit or a water pipe.
    - c. The Contractor shall correct all defects possible.
    - d. If the maximum number of unrepairable defective pairs exceeds 4% of the cable's pair count, the cable shall be deemed unacceptable and shall be replaced. Replace, re-terminate and retest new cable at no additional cost to the District.
  - 2. Test procedures:
    - a. TEST #1 - Continuity:
      - 1) Meter set for 20 ohm full scale ohm reading. Each pair shall be shorted at one end and the loop resistance value read at the other.
      - 2) The difference between the largest and the smallest resistance reading from each pair in the cable shall be no more than 10 percent of the largest reading.
    - b. TEST #2 - Balance, Polarity and Conductor Transpositions:
      - 1) Upon passing Test #1, the tester at one end of cable shall ground tip side of each pair in turn. The tester at other end of cable reads resistance to building ground of same conductor.
    - c. REQUIREMENT: Reading for each tip conductor in pair of approximately one-

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- half the loop resistance value from Test #1.
3. Test Report:
    - a. Submit Test Report. Documentation shall include loop resistance regarding any opens, shorts, transpositions found, as well as corrective action taken to correct any found opens, shorts, or transpositions.
  - G. Fiber Optic Cabling.
    1. Perform fiber optic cable testing on all installed fiber optic cabling. Submit test results.
    2. All testing procedures and field-test instruments shall comply with applicable requirements of:
      - a. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
      - b. ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
      - c. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
      - d. ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR.
      - e. ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
      - f. ANSI/TIA/EIA 526 7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
      - g. ANSI/TIA/EIA 526 14 A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
      - h. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
      - i. ANSI/TIA 568 C.3, Optical Fiber Cabling Components Standard.
      - j. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.
    3. Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as  
  
proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
      - a. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
      - b. Manufacturer of the test equipment used for the field certification.
      - c. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)
    4. Submit calibration certification for testing equipment to be used and certification of training of persons proposed to perform specified testing prior to scheduling testing.
    5. The District's Representative shall be provided with the opportunity witness and/or review field-testing.
    6. The District's Representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
    7. The District's Representative will select a random sample of 5% of the installed links. The District's Representative shall test these randomly selected links and the results are to be stored in the manner described in this section. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor shall repeat 100% testing at no cost to the District.

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8. Submit test report no later than five days after the cables are tested.

### **1.10 ACCEPTANCE OF FIBER OPTIC TEST RESULTS**

- A. Each cabling link shall be in compliance with the following test limits:
1. Optical loss testing
    - a. Singlemode links
      - 1) The link attenuation shall be calculated by the following formulas as specified in ANSI/TIA-568-C.0.
        - (a)  $\text{Link\_Atttn (dB)} = \text{Cable\_Atttn (dB)} + \text{Connector\_Atttn (dB)} + \text{Splice\_Atttn (dB)}$
        - (b)  $\text{Cable\_Atttn (dB)} = \text{Attenuation\_Coefficient (dB/km)} * \text{Length (Km)}$
        - (c)  $\text{Connector\_Atttn (dB)} = \text{number\_of\_connector\_pairs} * \text{connector\_loss (dB)}$
        - (d) Maximum allowable connector\_loss = 0.4 dB
        - (e)  $\text{Splice\_Atttn (dB)} = \text{number\_of\_splices} * \text{splice\_loss (dB)}$
        - (f) Maximum allowable splice\_loss = 0.05 dB
        - (g) The values for the Attenuation\_Coefficient (dB/km) are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

2. OTDR Testing. Not required if fiber passes required optical loss testing.
  - a. Reflective events (connections) shall not exceed 0.4 dB.
  - b. Non-reflective events (splices) shall not exceed 0.05 dB.
- B. All installed cabling links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the District.

## **PART 2 PRODUCTS**

### **2.01 COMMUNICATIONS CABLES AND RELATED**

- A. GENERAL:
1. Cabling shall be UL listed for the application and shall comply with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3 and NFPA 70.
  2. Ship cable on reels and/or in boxes bearing manufacture date for UTP in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project.
  3. Cabling manufactured more than 12 months prior to date of installation shall not be used.

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4. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
  - a. At plenums, provide type CMP or OFNP cabling.
  - b. At risers, provide type CMR or OFNR cabling
  - c. At horizontal wiring conditions, provide type CM or OFN cabling.
5. Refer to Section 27 14 00 - Communications Outside Plant Backbone  
Cabling for underground cabling installation

### 2.02 FIBER OPTIC CABLING, GENERAL REQUIREMENTS

#### A. General

1. Fiber count per cable to comply with minimum counts indicated on the plans.  
Plans indicate specific cable counts providing quantities of single mode fiber strands.
2. Quantities are minimum quantities. At Contractor's option, provide a greater number. Where a greater number are provided, terminate, test, label and document all strands on fiber patch panels and/or terminal boxes as indicated as if quantity provided were called out for on the plans.
3. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
  - a. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber plenum cable (OFNP), and nonconductive optical fiber riser cable (OFNR) rated cable in accordance with NFPA 70 and UL 910.
  - b. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70.
4. Fiber media shall, at minimum, meet the following performance standards:
  - a. ANSI/TIA 568-C.1
  - b. ANSI/TIA 568-C.3
5. Fiber media shall, at minimum, meet one of the following construction standards:
  - a. ANSI/ICEA S-87-640-2011 Fiber Optic Outside Plant Communications Cable
  - b. ANSI/ICEA S-83-596-2011 Indoor Optical Fiber Cables
6. Construction
  - a. Indoor: All dielectric, unless otherwise noted.
  - b. Outdoor: All dielectric, unless otherwise noted.
7. The cable cordage jacket, fiber, unit, and group color shall be in accordance with EIA TIA/EIA-598-B.
  - a. Colors shall be across specified storage/installation temperature range.
  - b. Means of providing conforming colors shall not degrade performance of cable.
8. Jacket:
  - a. Free of splits, holes or blisters.
  - b. Marked and listed in conformance with California Electric Code 770
  - c. Conform with
    - 1) UL 1666 and
    - 2) NFPA 70
  - d. Heavy duty construction, Fiberglass Epoxy Rod/Kevlar strength member(s).
  - e. Each fiber to be 100% attenuation tested by the Manufacturer prior to shipping. Manufacturer's test to be affixed to shipping reel.
  - f. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches. Hybrid fiber optic cable marking

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shall comply with TIA/EIA-598-B.

9. Performance:
  - a. All fibers in the cable must be usable and meet required specifications.
  - b. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
  - c. Temperature Sensitivity:
    - 1) Storage: -40C degrees to +70C degrees.
    - 2) Installation: -30C degrees to +70C degrees.
  - d. Variance:
    - 1) Single Mode:
      - (a) Average change, not more than 0.05 dB/km at 1550 -40C degrees to +70C degrees.
      - (b) Maximum change not more than 0.15 dB/km at 1550 nm.

### B. Fiber Strands, Singlemode - General

1. Meeting
  - a. ISO/IEC 24702 OS2
  - b. TIA 568C.3 and EIA TIA/EIA-492CAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture.
2. Construction:
  - a. Each optical fiber shall consist of a germania-doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.
  - b. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m<sup>2</sup>).
  - c. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
  - d. The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5 °C on the original shipping reel.
  - e. Single-mode (Dispersion Un-shifted): The single-mode fiber shall meet EIA/TIA-492CAAB, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak," and ITU recommendation G.652 (Categories A, B, C & D), "Characteristics of a single-mode optical fiber cable."
  - f. Meets or exceeds ISO/IEC 11801 OS2
  - g. Geometry
    - 1) Cladding Diameter (μm): 125.0 ± 0.7
    - 2) Core-to-Cladding Concentricity (μm): = 0.5
    - 3) Cladding Non-Circularity: = 0.7 %
    - 4) Mode Field Diameter (μm)
      - (a) 1310 nm: 9.2 ± 0.4
      - (b) 1550 nm: 10.4 ± 0.5
    - 5) Coating Diameter (μm): 245 ± 5
    - 6) Colored Fiber Nominal Diameter (μm): 249 - 259
    - 7) Fiber Curl radius of curvature (m): > 4.0 m
  - h. Optical
    - 1) Cabled Fiber Attenuation

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(dB/km) (a) 1310 nm: = 0.4

(b) 1550 nm: = 0.3

2) Point

discontinuity (dB)

(a) 1310 nm: =

0.05 (b) 1550 nm:

= 0.05

3) Macrobend Attenuation

Turns	Mandrel OD (mm)	dB
1	32 ± 2	≤ 0.05 at 1550 nm
100	32 ± 2	≤ 0.05 at 1310 nm
100	50 ± 2	≤ 0.05 at 1550 nm
100	60 ± 2	≤ 0.05 at 1625 nm

4) Cable Cutoff Wavelength (? ccf ) (nm): < 1260

5) Zero Dispersion Wavelength (?o) (nm): 1302 = ?o = 1324

6) Zero Dispersion Slope (So) (ps/(nm<sup>2</sup>•km)): = 0.092

7) Total Dispersion

(ps/(nm•km)) (a) 1285-

1330 nm: = 3.8

(b) 1550 nm: = 17.5

(c) 1625 nm: = 21.6

8) Cabled Polarization Mode Dispersion (psvkm): = 0.2

9) IEEE 802.3 GbE - 1300 nm Laser Distance (m): up to 5000

10) Water Peak Attenuation: 1383 ± 3 nm (dB/km): = 0.4

i. Manufacturer:

1) Corning 28e

2) OFS

3) or equal.

## PART 3 EXECUTION

### 3.01 GENERAL

- A. All system cabling and terminations be installed in accordance with the manufacturer's instructions and as shown.
- B. All necessary interconnections, services, and adjustments required for a complete and operable system shall be provided. All installation work must be done in accordance with the safety requirements set forth in the general requirements of ANSI C2 and NFPA 70.
- C. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.
- D. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.
- E. The Contractor shall be responsible for all damage to the cable during placement.

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1. Cabling shall be maintained free of splits, holes or blisters.
  2. Cabling shall not be painted or exposed to construction solvents or other caustic chemicals unless rated and warranted for such exposure by its manufacturer.
- F. Correct unacceptable wiring conditions including but not limited to:
1. Deformed, brittle or cracked insulation.
  2. Torn or worn cable jacket.
  3. Excessively scored cable jackets.
  4. Insulation shrunken or stripped further than 1/8" away from the actual point of connection within a connector, or on a punch block.
  5. Ungrommited, unbushed, or uninsulated wire or cable entries.
  6. Deformation or improper radius of wire or cable.

### 3.02 SPLICING

- A. All interior wire and outside plant/exterior cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.
1. At designated splices, maintain conductor color code across all splices.
    - a. All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels or equipment enclosures.
    - b. Within buildings, make splices only in designated terminal cabinets and/or on designated equipment backboards.
- B. Backbone Copper Cabling
1. At interior: Provide splice free cabling between Telecommunications Rooms, and from Telecommunications rooms to all locations in the same building indicated for backbone copper cabling media.
  2. At outside plant: Do not splice at exterior, unless different splicing is indicated on Plans or is unavoidable due to either cable length exceeding the maximum commercially available in the indicated pair count, or due to on-site pulling conditions. In either condition, provide documentation of the condition to the District's Representative for review prior to proceeding. If the District's Representative concurs that the conditions warrant the splice:
    - a. Splice only within manholes, not vaults or pullboxes.
    - b. Provide specified multipair splices assembly.
    - c. Protect the splice in an encapsulated splice case fastened to a pair of cable rack arms.
    - d. Document the installed splice case on the record drawings.
    - e. Encapsulated Closures
      - 1) Adhere to all manufacturer installation guidelines.
      - 2) Support closure at both ends via racks and steps, so that no unnecessary stress or weight is applied to the splice case or associated conductors.
      - 3) End Caps and Closure Extension Sleeves
        - (a) Adhere to all manufacturer installation guidelines.
      - 4) Encapsulants
        - (a) Adhere to all manufacturer installation guidelines.
      - 5) Splicing Tapes
        - (a) Adhere to all manufacturer usage guidelines.
      - 6) Gel Stripper
        - (a) Adhere to all manufacturer usage guidelines.

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- C. Fiber Optic Cabling
  - 1. At interior: Provide splice free cabling between Telecommunications rooms, and from Telecommunications rooms to all locations in the same building indicated for backbone fiber cabling media.
  - 2. At outside plant: Do not splice at exterior unless splicing is indicated on Plans or is unavoidable due to either cable length exceeding the maximum commercially available in the indicated strand count, or due to on-site pulling conditions. In either condition, provide documentation of the condition to the District's Representative for review prior to proceeding. If the District's Representative concurs that the conditions warrant the splice:
  - 3. Splice only within manholes.
    - a. Provide fusion splices.
    - b. Protect the splice in a fiberoptic splice case fastened to a pair of cable rack arms.
    - c. Document the installed splice case on the record drawings.
  - 4. Splicing, where required due to field pulling conditions and/or cable length limits, shall be provided at no additional cost to the District.
- D. Ensure that all splice closures are properly sealed for protection of the cable and splices.

### **3.03 PULLING IN**

- A. Verify that all raceway has been de-burred and properly joined, coupled, and terminated prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.
- B. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.
- C. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.
- D. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.
- E. Pull Rope/Tape
  - 1. For OSP installations, pull new pulling 'mule' tape through all conduits while placing new backbone cable. Leave a pulling 'mule' tape in the utilized conduits for future use.
  - 2. For ISP installations, pull new pull rope through all conduits while placing new backbone cable. Leave a pull rope in the utilized conduits for future use.
- F. Do not leave cable slack on cable runway
- G. Firestop all sleeves, station cable conduit and ISP backbone conduit openings through rated partitions after the cable installation is complete.

### **3.04 SUPPORT**

- A. Support: Provide support for all cabling. Conform to the restrictions of the California Electric Code and Section 27 05 29. Secure all wire and cable run vertically for continuous distances greater than thirty (30) feet. Secure robust non-coaxial cables with screw-flange nylon cable ties or similar devices appropriate to weight of cable. For all

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other cables, provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable.

- B. Separation from sources of Electromagnetic Interference: Conform with the requirements of ANSI/TIA-569-C, 9.3 Pathway Separation from EMI sources.

### **3.05 FIBER OPTIC CABLE TESTING**

#### **A. ADMINISTRATION**

- 1. Administration of the documentation shall include test results of each fiber link.
- 2. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- 3. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

#### **B. GENERAL**

- 1. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- 2. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

#### **C. OPTICAL FIBER CABLE TESTING**

- 1. Field-test instruments shall have the latest software and firmware installed.
- 2. Link test results from the OLTS shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- 3. Testing shall be performed on each cabling segment (connector to connector).
- 4. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. .
  - a. Optical loss testing
    - 1) Backbone link
      - (a) Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper or the equivalent method.
      - (b) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
      - (c) Use the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1 or the equivalent method. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.
      - (d) Each fiber link shall be tested in both directions.
    - b. Polarity Testing
      - 1) Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA 568 C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

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5. Test Results Documentation
  - a. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used. PDFs shall not be used
  - b. The test results documentation shall be available for inspection by the the District’s representative during the installation period and shall be passed to the District’s representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.
  - c. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to District acceptance of the building. This CD-ROM shall include the software tools required to view, inspect, and print any selection of the test reports.
  - d. Circuit IDs reported by the test instrument should match the specified label ID (see Error! Reference source not found. of this Section).
  - e. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information:
    - 1) The identification of the District site as specified by the District’s Representative.
    - 2) The name of the test limit selected to execute the stored test results
    - 3) The name of the personnel performing the test
    - 4) The date and time the test results were saved in the memory of the tester
    - 5) The manufacturer, model and serial number of the field-test instrument
    - 6) The version of the test software and the version of the test limit database held within the test instrument
    - 7) The fiber identification number
    - 8) The length for each optical fiber
      - (a) The index of refraction used for length calculation when using a length capable OLTS
    - 9) Test results to include OLTS attenuation link measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
    - 10) The overall Pass/Fail evaluation of the link-under-test for OLTS measurements.

### **3.06 CATEGORY RATED STATION PROOF OF PERFORMANCE DEMONSTRATION**

- A. Comply with the requirements of Part 1 of this Section and the following:
  1. After submittal of test result documentation and the associated as-built drawings, the District's Representative shall randomly pick five percent (5%) of the submitted cable plant installation for re-test.
  2. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the District.

### **3.07 LABELING**

- A. Reference Section 27 05 53 - Identification For Communications Systems, the plans

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and the specifications.

- B. Comply with labeling instructions to include, but not be limited to, the following:
  - 1. Label technology to be utilized;
  - 2. Label content;
  - 3. Label placement

### **3.08 REMOVAL OF ABANDONED CABLING**

- A. The California Electrical Code (CEC) requires all unused telecommunications cable intended for future use to be terminated in a patch panel or cross-connect and labeled for such use. Any other unused cable is considered abandoned including cable abandoned due to installation of new cabling under the work of this Project.
- B. Abandoned cable must be removed and disposed of, per CEC 770.53(A) & 770.53(B) (fiber) and 800.52(B), 800.53(A) & 800.53(B) (copper). Similar requirements are elsewhere in the CEC for other types of cable.
- C. Refer to Division 1 regarding means and methods to be employed in the disposal of construction waste materials including material subject to recycling such as abandoned copper cabling.

**END OF  
SECTION**

## **SECTION 271113 - COMMUNICATIONS ENTRANCE PROTECTION**

### **PART 1 GENERAL**

#### **1.01 SCOPE OF WORK SCOPE OF WORK**

- A. Section includes provision of lightning protection of all new outside plant copper cabling where spans exceed 140 feet between structures in pathway that is non-metallic, including below grade.
- B. Related Work Under Other Sections
  - 1. Related Sections:
    - a. Section 27 05 00 - Common Work Results for Communications
    - b. Section 27 05 26 - Grounding and Bonding for Communications Systems
    - c. Section 27 14 00 - Communications Outside Plant Backbone Cabling

#### **1.02 REFERENCES**

- A. Usage: In accordance with Division 1.
- B. In Addition to the requirements of Section 27 05 00 - Common Work Results for Communications and 27 10 00 - Structured Cabling, conform to the applicable portions of the following standards agencies:
  - 1. Underwriters Laboratories, Inc. (UL)
    - a. UL 497 (Dec. 15, 1978, 4th Ed.; Rev. thru Jun. 14, 2004) Protectors for Paired Conductor Communication
  - 2. Code of Federal Regulations (CFR):
    - a. 7 CFR 345 Bulletin # 345-65 REA Specification for Shield Bonding (Mar. 1985)
    - b. 7 CFR 345 Bulletin # 345-72 Specifications for Filled Splice Closures, PE-74 (Oct. 1985)
    - c. 7 CFR 345 Bulletin # 345-83 Specification for Gas Tube Surge Arresters, PE-80 (Oct. 1982)
    - d. 7 CFR 1751 Bulletin # 1751F-644 Underground Plant Construction (Aug. 2002)
    - e. 7 CFR 1753 Bulletin # 1753F-201 Acceptance Tests and Measurements of Telecommunications Plant (Jun. 1997)
    - f. 7 CFR 1753 Bulletin # 1753F-401 Standards for Splicing Copper and Fiber Optic Cable (Feb. 1995)
    - g. 7 CFR 1753 Bulletin # 1753F-207 Specifications for Terminating Cables, PE-87 (Jul. 1994)
    - h. 7 CFR 1755-4-2004 Telecommunications Standards and Specifications for Materials, Equipment, and Construction.

#### **1.03 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

#### **1.04 DELIVERY, STORAGE AND HANDLING**

- A. Procedures: In accordance with Division 1 and Section 27 10 00 - Structured Cabling, Basic Materials and Methods.

#### **1.05 SEQUENCING**

- A. Not Used.

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## **1.06 QUALITY ASSURANCE**

- A. Unless otherwise noted, protect each pair of each end of each outside plant cable installed under the work of this project.

## **PART 2 PRODUCTS**

### **2.01 WALL MOUNTED PROTECTORS**

- A. Category 3 Protector Fields & Modules, Stub to 110
1. Drawing references:
    - a. LP110TB6 6 pair
    - b. LP110TB25 25 pair
    - c. LP110TB50 or LP50 50 pair
    - d. LP110TB100 or LP100 100 pair
    - e. LP200 Provide two LP100
  2. Approvals
    - a. UL 497 Listed.
    - b. RUS approved.
  3. Features/Functions/Construction.
    - a. Accommodates Protector Modules specified herein. Coordinate selected devices to preserve UL Listing.
    - b. Wall mount enclosure, with hinged cover
    - c. Quiet front - no unprotected parts exposed to end user.
    - d. Physical layout compatible with 110 series punch blocks.
    - e. Unprotected input: Swivel Cable stub, length to suit application. Terminated in 3M 710 Connector, unless otherwise noted
  4. Protected output: Type 110 block.
    - a. Heat Coil Resistance: 4 ohm
    - b. Performance:
    - c. Voice Pairs:
      - 1) Gas or Solid State.
      - 2) Breakdown Voltage - 265 to 465 V.
      - 3) Size: 100 Pair, u.o.n.
      - 4) Protector Quantity:
      - 5) Unless otherwise noted, protect both ends of each outside plant pair installed.
      - 6) Provide 1005 of protectors as Gas Tube with 4 ohm heat coils
  5. Manufacturer, Protector Field:
    - a. Circa Enterprises, Inc. 1880ECS1 series
    - b. Emerson Network Power
    - c. 3M.
    - d. Porta Systems.
    - e. or equal.
  6. Manufacturer, Protector Module:
    - a. Circa Enterprises, Inc.
    - b. Emerson Network Power
    - c. 3M.
    - d. Porta Systems.

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e. or equal.

### **PART 3 EXECUTION**

#### **3.01 SURGE PROTECTION:**

- A. Unless otherwise noted, all cables and conductors, except fiber optic cable, which are installed by this project to provide inter-building communication connections, shall have surge protection installed at each end which meets the requirements of REA PE-60.
- B. Termination:
  - 1. Provide lightning protection of all new outside plant copper cabling where spans exceed 140 feet between structures in pathway that is non-metallic, including below grade.
  - 2. Provide protector modules equal to the number of installed pairs.
- C. Locate protection as indicated on the backboard elevations on the plans.
- D. If protectors are not indicated on a backboard elevation, locate between +24" and 7'-0" above the finished floor at the left edge of the backboard, after allowing for OSP cabling wrapping and management at the backboard edge.
- E. Bond protector field enclosures to ground in accordance with the most restrictive of the California Electrical Code, 27 05 26 - Grounding and Bonding for Communications Systems and the manufacturer's instructions.

**END OF SECTION**

## **SECTION 271116 - COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES PART 1**

### **GENERAL**

#### **1.01 SCOPE OF WORK**

- A. Communications racks and cabinets.

#### **1.02 RELATED WORK BY OTHERS**

- A. By the District's Network Integrator
  - 1. Data switching equipment
  - 2. Rack Mounted UPS and Extender Battery Packs
  - 3. Rack mounted power strips/PDU's

#### **1.03 RELATED WORK IN OTHER SECTIONS**

- A. Division 26
  - 1. Power at equipment racks mounted to cable tray above floor mounted racks and internal to wall mounted racks unless otherwise noted.
- B. Section 27 05 26 - Grounding and Bonding for Communications Systems
  - 1. Bonds racks and cabinets.
- C. Section 27 05 33 - Conduits and Backboxes for Communications Systems
  - 1. Signal systems raceways at communications rooms
- D. Section 27 05 36 - Cable Trays for Communications Systems
  - 1. Signal systems cable tray at communications rooms
- E. Section 27 13 00 - Communications Inside Backbone Cabling
  - 1. Inside Backbone Terminations at communications rooms.
- F. Section 27 14 00 - Communications Outside Plant Backbone Cabling
  - 1. Outside plant backbone cabling, including Entrance Protection and Termination at communications rooms.
- G. Section 27 15 00 Communications Horizontal Cabling
  - 1. Rack mounted horizontal patch panels.

#### **1.04 REFERENCES**

- A. American National Standards Institute (ANSI)
  - 1. EIA-310-D (1992) Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D)
  - 2. ANSI-J-STD-607-B (2011) Generic Telecommunications Bonding and Ground (Earthing) for Customer Premises

#### **1.05 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

#### **1.06 DELIVERY, STORAGE AND HANDLING**

- A. Procedures: In accordance with Division 1 and Section 27 10 00 - Structured Cabling, Basic Materials and Methods.

#### **1.07 SEQUENCING**

- A. Not Used.

### **PART 2 PRODUCTS**

#### **Communications Cabinets, Racks, Frames And Enclosures - 271116**

## 2.01 GENERAL

### A. KEYS

## 2.02 Key all boxes, cabinets, enclosures, panels, controls, doors and related provided for similar usage within a system identically. EQUIPMENT ENCLOSURE SYSTEMS

### A. General:

1. Provide enclosure systems including, but not limited to enclosures, cabinets, cases and related panels and accessories as specified herein. Provide size and quantity as shown on drawings or scheduled.
2. Provide color as shown on drawings. If no color is shown on drawings, submit manufacturer's standard color chips for selection.
3. Provide enclosure systems conforming to the IBC, latest edition, for bracing design.
4. Equipment Enclosures: Each rack provided with frame angles tapped 10-32, ANSI/EIA 310-D Universal Spaced.

### B. Rack, Wall Mount, Three Section, Horizontal Pivoting

1. Drawing Reference: R12X, where X is indicated panel opening size.
2. Construction:
  - a. Wall mounted, three part sectional, with:
    - 1) Steel, fixed mount wall terminal section
    - 2) Steel, center swing out section
    - 3) Vented steel locking front door.
  - b. Fully depth-adjustable front and rear mounting rails.
  - c. Combined depth of swing-away center section and fixed rear section to be not less than as scheduled below.
  - d. Center section swing is reversible, and can be both keylocked and padlocked
3. Approvals:
  - a. UL Standards Tested: UL2416
  - b. ASCE: 7-10
4. UL Load Capacity: 300 pounds minimum.
5. Seismic Certified: 140 pounds minimum, dynamic load.
6. Meets 2010 CBC; 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity, Seismic Use Group III, Zone 4 or Seismic Design Category (SDC) "D" with lateral force requirements for protecting 140 lbs. of essential equipment in locations with the highest level of seismicity and top floor or rooftop installations with an Importance factor (Ip) of 1.5
7. Front door 64% Open Minimum, Center Section vented to permit air intake from front and discharge to sides.
8. Drawing Reference Schedule:

R12 Designator	Nom. Outside Width (in.)	Nom. Outside Depth (in.)	Nom. Outside Height (in.)	Panel Opening Size in Rack Units (1 R.U. = 1.75")
R12A	23.4	17.3	24.5	10

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R12B	23.4	22.3	24.5	10
R12C	23.4	17.3	28	12
R12D	23.4	22.3	28	12
R12E	23.4	26.3	28	12
R12F	23.4	32.3	28	12
R12G	23.4	17.3	35	16
R12H	23.4	22.3	35	16
R12I	23.4	17.3	38.5	18
R12J	23.4	22.3	38.5	18
R12K	23.4	26.3	38.5	18
R12L	23.4	32.3	38.5	18
R12M	23.4	17.3	43.75	21
R12N	23.4	22.3	43.75	21
R12O	23.4	17.3	49	24
R12P	23.4	22.3	49	24
R12Q	23.4	26.3	49	24
R12R	23.4	32.3	49	24
R12S	23.4	17.3	68.25	35
R12T	23.4	22.3	68.25	35
R12U	23.4	26.3	68.25	35

## 9. Manufacturers

- a. Middle Atlantic Products DWR Series LVFD Front Door, DWR-RR rear rail kit and DWRSR-ZL Latch. (Design Basis).
- b. Hubbell Wall Mount Cabinets
- c. B-Line
- d. CPI
- e. Hoffman
- f. Damac.
- g. Encore.
- h. or equal.

## C. Rack, Floor Mount, Three Section, Horizontal Pivoting

## 1. Construction:

- a. Floor mounted, w/ll braced three part sectional, with:
  - 1) Steel, fixed mount floor/wall terminal section
  - 2) Steel, center swing out section
  - 3) Vented steel locking front door.
- b. Fully depth-adjustable front and rear mounting rails.
- c. Combined depth of swing-away center section and fixed rear section to be not less than as scheduled below.
- d. Center section swing is reversible, and can be both keylocked and padlocked

## 2. Approvals:

- a. UL Standards Tested: UL2416
- b. ASCE: 7-10

## 3. UL Load Capacity: 500 pounds minimum.

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4. Seismic Certified: 336 pounds minimum, dynamic load.
5. Meets 2010 CBC; 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity, Seismic Use Group III, Zone 4 or Seismic Design Category (SDC) "D" with lateral force requirements for protecting 140 lbs. of essential equipment in locations with the highest level of seismicity and top floor or rooftop installations with an Importance factor (Ip) of 1.5
6. Front door 64% Open Minimum, Center Section vented to permit air intake from front and discharge to sides.
7. Drawing Reference Schedule:

R13 Designator	Nom. Outside Width (in.)	Nom. Outside Depth (in.)	Nom. Outside Height (in.)	Panel Opening Size in Rack Units (1 R.U. = 1.75")
R13E	23.6	32.3	90.75	40

### 8. Manufacturers

- a. Middle Atlantic Products SR-40-32 , LVFD-40 Door, DWR-RR40 rear rails and DWRSR-ZL latch (Design Basis).
  - b. Hubbell
  - c. B-Line
  - d. CPI
  - e. Hoffman
  - f. Damac.
  - g. Encore.
  - h. or equal.
- D. Equipment Rack, Seismic Front, Rear and Side Access, with Vertical Wire Management.
1. Drawing References: R28
  2. Minimum Features, Function & Construction:
    - a. Manufacturer tested Zone 4 assembly, rated for at least 900 pounds of uniformly distributed load, upper floor load, of essential equipment per California Building Code/Uniform Building Code.
    - b. Fully welded construction provides:
      - 1) Static load capacity: 10,000 lbs.
      - 2) UL Listed load capacity: 2,500lbs.
      - 3) Seismic Certified load capacity: 755 lbs.
    - c. Seismic certified to the following codes and standards: 2007 & 2010 CBC; 2006, 2009 & 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity - Zone 4 or Seismic Design Category (SDC) "D". Intended for use in Mission Critical and/or High-Importance Installations in locations with the highest level of seismicity and top floor or rooftop installations including those within UBC and CBC Essential facilities or IBC, ASCE 7, and NFPA 5000 Seismic Use Group III

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- facilities. For all codes, the Importance factor (Ip) is 1.5.
- d. Vertical Height (Min): 44 RU
  - e. Outside depth: 40" minimum - 42 inches maximum.
  - f. Width: Not to exceed 30 inches
  - g. Lockable, 70% open area perforated mesh full height front and rear doors:
    - 1) Front door with wire mesh insert covers rack contents - swing shall be field adjustable to swing from either right or left.
    - 2) Rear doors to be a pair of half width doors, each with a wire mesh to cover rack contents.
    - 3) Wire mesh, vertical center split rear door pair.
  - h. Front and rear 19" mounting rail pairs DIN square holes on EIA spacing standard are fully adjustable in depth of setback from front to rear.
  - i. Vertical cable management rings, continuous, full height cable management system shall be installed:
    - 1) fully inside of the rack enclosure, with 2" minimum clearance behind front and rear rack frame.
    - 2) fully outside (to left of left rail and to right of right rail, and out of conflict with EIA Rails. Cable management system mounting shall not occupy rail screw openings.
    - 3) Front managers shall be accessible from front in fully loaded equipment rack.
    - 4) Rear managers shall be accessible from rear in fully loaded equipment rack.
  - j. 60% or greater perforated top panel occupying at least 50% of the stop surface of the cabinet allows passive heat radiation from rack interior to the exterior.
  - k. Cutouts and removable covers in cabinet top accommodates vertical transition of cabling from tray above into rack interior.
  - l. Gangable. Racks have been designed such that they are suitable for installation either as a single, standalone unit, or in a row of identical racks (gangable).
    - 1) Single rack installation. Provide side panels at both sides. Multirack installation in a row. Bolt racks together using means provided by manufacturer. Omit side panels except at ends of row of racks - provide at ends of rows of racks.
3. Manufacturers. Provide manufacturer's accessories or 3rd party accessories as specified elsewhere in this Section for other specified elements. Coordinate selected shelves, fans and similar with rack submitted for finish and mounting means.:
- a. Middle Atlantic DRK19-44-42PRO with DLVFD-44 front door, DCLVRD-44 rear doors, MRK-Z4 Base angles, 2 pair DRK-44DUCT (front and rear, 4 total vertical ducts), MW-LVT 64% open area top insert. Keylocked side panels SPN-44-36 at ends of rows.
  - b. APC Infrastructure
  - c. Hoffmann
  - d. Liebert/Knurr
  - e. Tripplite
  - f. Wrightline Paramount, Vantage or Vantage 2.
  - g. or equal.

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### E. Equipment Enclosure, NEMA 3R

1. Drawing References: R40
2. Minimum Features, Function & Construction

#### a. General:

- 1) Cabinet to be designed by the manufacturer to serve as a rack mount enclosure intended to house electronic controls, terminals and instruments, and to provide protection from rain, sleet, snow, dripping water and corrosion.
- 2) The cabinet and door(s) shall be constructed from 5052-H32 sheet aluminum alloy which has a thickness of 0.125 inch. External welds shall be made by using the Heliarc welding method; internal welds will be made by the wire welding method. All welds shall be neatly formed and free of cracks, blow holes and other irregularities.
- 3) All inside and outside edges of the cabinet shall be free of burrs.
- 4) The cabinet shall be designed with a crowned top or equivalent method to prevent the accumulation of water on its top surface.
- 5) The door opening(s) shall be double flanged on all four (4) sides which increases strength around openings and keeps dirt and liquids from entering the enclosure when door is opened.
- 6) Door restraint(s) shall be provided to prevent door movement in windy conditions.
- 7) Enclosure shall incorporate manufacturer's 800 BTU minimum air conditioning assembly providing cooling of enclosure interior without air exchange between exterior and interior of enclosure.

#### b. Nominal Size:

- 1) 67" High x 24" wide x 38" deep

#### c. Door/Hardware

- 1) The cabinet front and rear doors will be a minimum of 80% of the front and rear surface area and shall be hinged on the same side when facing the cabinet.
  - (a) The doors shall be furnished with a gasket that satisfies the physical properties as found in UL508 table 21.1 and shall form a weathertight seal between the cabinet and door.
  - (b) The closed doors will be flush with the side(s) of the enclosure.
- 2) The hinges shall be bolted to the cabinet and door utilizing 1/4-20 stainless steel carriage bolts and nylock nuts.
  - (a) The hinges will be made of 0.075 inch stainless steel with a 0.250 inch diameter stainless steel hinge pin.
  - (b) The hinge pin shall be capped top and bottom by weld to render it tamperproof. All bolt holes shall be gasketed.
- 3) The latching mechanism shall be a three-point draw roller type.
  - (a) Pushrods will be turned edgewise at the outward supports and shall be 0.250 inch by 0.750 inch aluminum, minimum.
  - (b) Rollers shall have a minimum diameter of 0.875 inch and will be made of nylon. The center catch shall be fabricated from 0.187 aluminum, minimum.
- 4) An operating handle shall be furnished.

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- (a) The handle will be stainless steel with a 3/4 inch diameter shank.
    - (b) The latching handles shall have a provision for to accept a District furnished padlocking in the closed position.
    - (c) A light/alarm switch bracket shall be provided.
  - d. Equipment Mounting
    - 1) The enclosures shall be equipped with mounting brackets that accommodate the mounting of a 19" rack frame assembly.
  - e. Cabinet Finish
    - 1) Unless otherwise specified, the outside surface of the cabinet shall have a smooth, uniform, natural aluminum finish.
      - (a) If painted, the following steps shall be taken as a minimum requirement:
        - (1) The cabinet door and any other parts to be painted will be treated with an iron phosphate coating conversion technique.
        - (2) After phosphatizing, the parts shall be baked to eliminate any moisture in seams.
        - (3) The finishing coat of a polyester powder will be baked at 400-450 degrees F for ten (10) minutes.
        - (4) The finish shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters and other defects that would impair serviceability or detract from general appearance.
  - f. Internal Rack Frame
    - 1) 30 EIA 310-D Rack Units (RU) minimum.
    - 2) 29" rack frame depth between front and rear EIA mounting rails minimum
  - g. Cabinet Mounting
    - 1) Enclosures intended for pedestal mounting shall be provided with a reinforced base plate with gasketed mounting holes.
  - h. Insulation
    - 1) Provide insulation sufficient to reflect out of the cabinet 95% of the incoming radiant solar heat.
  - i. Sushade
    - 1) Provide with manufacturer's custom aluminum sunshade kit selected and configured to reduce solar exposure during peak months.
- 3. Approvals
  - a. Nationally recognized testing laboratory: UL, ETL or equal.
  - b. NEMA 3R Construction
- 4. Manufacturers:
  - a. APX Enclosures, Inc. NEMA 3R Rack Mount Enclosure Model RM672438 with manufacturer's Air Conditioning system and Climate Control insulation treatment and with custom manufacturer Sunshade and RM672438 rack frame.
  - b. Hoffmann
  - c. Electrorack
  - d. DDB Unlimited
  - e. Or equal.

### 2.03 RACK PANELS AND ACCESSORIES

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- A. Rack Mounting Screws:
  - 1. Screws 10-32; length as required for at least 1/4" excess when fully seated; oval head with black plastic non marring cup washer or equivalent ornamental head; nickel, cadmium or black plated; Phillips, Allen Hex, Square-Tip or Torx drive. Slotted screws are not acceptable.
- B. Blank Panels:
  - 1. Construction
    - a. 16 gauge minimum cold rolled steel
    - b. Powder coat finish to match rack color, unless otherwise noted
  - 2. Manufacturers
    - a. Middle Atlantic Products EB or FEB Series.
    - b. Ortronics Filler Panels.
    - c. CPI Snap-In Filler Panel
    - d. Atlas Sound S19 Series.
    - e. BGW Systems Inc. Flanged Steel Blank Panels
    - f. Dukane
    - g. Elkay
    - h. Lowell Series L3
    - i. Zero ZP112000 Series.
    - j. Hubbell
    - k. or equal.
- C. Vent Panels:
  - 1. Construction
    - a. 20 gauge minimum cold rolled steel
    - b. 1/8" minimum holes, at least 70% open total panel cross-section.
    - c. Powder coat finish to match rack color, unless otherwise noted
  - 2. Manufacturers
    - a. Atlas Sound SVP Series.
    - b. BGW Systems Inc. Perforated Vent Panels
    - c. House of Metal Enclosures (HOME) Series PRP.
    - d. Lowell Series L5
    - e. Middle Atlantic Products VT Series.
    - f. Zero.
    - g. or equal.
- D. Vertical Lacer Strips
  - 1. 44RU high vertical steel strips with points for attachment of velco cable ties at at least 6" o.c.
  - 2. Manufacturer:
    - a. Middle Atlantic LACE-44LP
    - b. APW
    - c. or equal.
- E. Horizontal Lacer Bars
  - 1. EIA 19" Width steel strips or bars suitable to provide support to large cable dressed horizontally through racks
  - 2. Size to suit load and mounting width.

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3. Manufacturer:
  - a. Middle Atlantic LBP-1R4, LBP-1.5 and LBP-1S.
  - b. APW
  - c. or equal.
- F. Seismic Hold-down Equipment Straps
  1. Drawing Reference: None - Provide as required to secure equipment that can not be screw fastened to mounting shelves.
  2. Manufacturers:
    - a. BGW Systems
    - b. Everest Electronic Equipment Lock Down Kit
    - c. Ergotron
    - d. Chatsworth Products
    - e. Middle Atlantic Products Q-Safety, Inc.
    - f. or equal.

### PART 3 EXECUTION

#### 3.01 MOUNTING

- A. Unless otherwise noted, all floor supported equipment racks shall be bolted to the structure in accordance with the requirements of the CBC and the DSA approved mounting details.
- B. Rows of identical racks shall be bolted together, in addition to being bolted to the floor, and bonded to form a single electrical ground plane.
- C. Wall mounted equipment racks and cabinets shall similarly be bolted to structural members in accordance with the requirements of the CBC and the DSA approved mounting details.

#### 3.02 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

- A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.
- B. Provide permanent labels for all equipment and devices.
- C. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.
- D. Recess rails prior to assembly to permit free closure of doors over installed equipment and wire managers.
- E. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.
- F. Where wiring of mixed types are called for on the plans, maintain separation of wiring classifications as specified in the individual sections of Division 27.
- G. Provide vertical wire management of cabling within the rack independent of the adjustable EIA mounting rails. Vertical wiring management provided by the contractor within the rack shall not prevent such rails from being moved as required by the District.

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- H. Dress and support cabling at a minimum of 24 inch on center. Dress all cabling in swing racks to prevent motion of cabling relative to patch panel during operation of the swing rack.
- I. Access shall not require demounting or de-energizing of equipment or cabling. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.
- J. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.
- K. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels which will remain in place when active equipment is removed for possible service.
- L. Coordinate the design and execution of wire harnessing of multi-bay audio and video rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.

### **3.03 SIGNAL GROUNDING & BONDING PROCEDURES**

- A. Comply with National Electrical Code. Bond equipment racks to ground in accordance with the California Electric Code, ANSI/ TIA 607-B and Section 27 05 26
- B. Equipment enclosures shall not be permitted to touch each other unless bolted together and electrically bonded.

**END OF SECTION**

**SECTION 271119**  
**COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS**

**P1 GENERAL**

**1.01 SCOPE OF WORK**

- A. This Section defines material standards for:
  - 1. Copper Termination Assemblies, including
    - a. Rack and cabinet mounted copper patch panels
    - b. Backboard, rack and cabinet mounted terminal blocks
  - 2. Fiber Termination Assemblies, including:
    - a. Fiber connectors
    - b. Fiber Consolidation Panels
    - c. Rack and cabinet mounted fiber patch panels
    - d. Backboard mounted fiber terminal boxes
  - 3. Hybrid Copper/Fiber Termination Assemblies

**1.02 RELATED WORK UNDER OTHER SECTIONS**

- A. Section 27 05 00 - Common Work Results for Communications
- B. Section 27 05 26 - Grounding and Bonding for Communications Systems
- C. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
- D. Section 27 11 13 - Communications Entrance Protection
- E. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
- F. Section 27 11 23 - Communications Cable Management
- G. Section 27 13 00 - Communications Interior Backbone Cabling
- H. Section 27 14 00 - Communications Outside Plant Backbone Cabling
- I. Section 27 15 00 - Communications Horizontal Cabling

**1.03 REFERENCES:**

- A. ELECTRONIC INDUSTRIES ALLIANCE (EIA)
  - 1. EIA-310-D (1992) Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D)

**1.04 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Procedures: In accordance with Division 1 and Section 27 10 00 - Structured Cabling, Basic Materials and Methods.

**1.06 SEQUENCING**

- A. Not Used.

**PART 2 PRODUCTS**

**201 COPPER CABLE TERMINATION DEVICES AND RELATED**

- A. Category 5e Terminal Block.
  - 1. Drawing reference(s):
    - a. 110TB6                      6 pair
    - b. 110TB25                    25 pair
    - c. 110TB50                    50 pair
    - d. 110TB100                  100 pair
    - e. 110TB300                  300 pair
    - f. 110TB600                  600 pair

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2. General: Insulation displacements connector blocks consisting of oxygen free mechanical fastening system arranged in a flame-retardant molded plastic fastened to a mounting bracket.
  3. Features/Functions
    - a. "110 type" punch down type.
    - b. Cable routing space behind the blocks.
  4. Conforms with REA PE-87.
  5. Performance:
    - a. Complies with Commscope/Systimax 110 Premises Distribution System Specifications
    - b. Electrical (measured at 50 MHz).
    - c. Resistance: Not more than .4 ohms/termination
    - d. Inductance: Not more than 13 nH/termination
    - e. Capacitance:
      - 1) Not more than .9 pF/termination, same pair.
      - 2) Not more than .7 pF/termination, next pair.
  6. Construction/Implementation
    - a. Provide complete with standoff mounting brackets
    - b. Provide trough at the bottom of each column of blocks.
    - c. Unless otherwise noted, provide WMP between each column of blocks, and at the outside edges of each group of block columns.
  7. Manufacturer:
    - a. Siemon S110 or S110M Modular Tower System
      - 1) S110M42-300FT300 Pair
      - 2) S110M42-400FT400 Pair
      - 3) S110M42-500FT500 Pair
      - 4) S188WDTrough
    - b. Ortronics.
      - 1) 110-PB2-300FT300 Pair
      - 2) 110-PB2-900FT900 Pair
    - c. Hubbell Wall Mount Kits, 110
    - d. AMP CrossConnect Distribution Frame Kit 56985\* Series
    - e. Leviton
    - f. Commscope/Systimax
    - g. Commscope/Uniprise
    - h. Wiremold.
    - i. Panduit.
    - j. or equal.
- B. Rack Mount Category 6 Terminal Block
1. Drawing reference
    - a. 110TB050RM 50 pair
    - b. 110TB100RM 100 pair
    - c. 110TB200RM 200 pair
    - d. 110TB300RM 300 pair
  2. Construction
    - a. Category 6 110 Block mounted on a 19" rack panel.
    - b. Otherwise as for 110TB
  3. Manufacturer
    - a. Panduit P110B100R2Y
    - b. Siemon
    - c. Ortronics
    - d. Hubbell
    - e. Leviton

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f. or equal

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- C. Data Patch Panels, Keystone, Rack Mounted
  - 1. Drawing Reference:\*\*\* C6\*PP, where \*\*\* refers to port count.
  - 2. Functions/Features:
    - a. 19" EIA rack mountable.
    - b. At least 24 ports per EIA rack unit (1.75").
    - c. Industry standard keystone openings in steel plate
    - d. arranged in rows on steel panel,
    - e. jacks on front,
    - f. terminations on rear.
    - g. Port identifier label space on front.
    - h. Fill each opening with Category 6 and Category 6A keystone jacks to match cable count on plans and schedules. Coordinate jack selection with patch panel construction to ensure that jack width behind the panel does not prevent fully loading panel.
    - i. Integral cable management bar at rear.
  - 3. Manufacturer
    - a. Leviton QuickPort High Density Multimedia Patch Panels with Management Bar
    - b. Panduit Netkey
    - c. Hubbell Xcelerator Series Panels
    - d. Molex EZ Patch
    - e. ADC/Krone
    - f. Ortronics
    - g. or equal.
- D. Category 3 Rack Mount Patch Panels with Pre-Wired RJ-21C (50 Pin) connector, 8P4C
  - 1. Drawing reference:
    - a. \*\*PWC3PP, where \*\* designates port count.
  - 2. Features/Functions/Construction:
    - a. 19" EIA rack mount panel.
    - b. Front face - RJ45
  - 3. Rear Face - Two pre-wired RJ21C connector (50 Pin).
  - 4. Printed Circuit board linking RJ45's to two RJ21C (Amphenol Connectors) to center 2 pairs (pins 3-6) on RJ45's.
  - 5. Approvals
    - a. ANSI/TIA-568-C.2 for Category 3 performance
    - b. ANSI/TIA-1096A (formerly FCC Part 68)
    - c. Nationally recognized test laboratory (NRTL) listed
  - 6. At least 24 Jacks per rack unit (RU).
  - 7. Manufacturers:
    - a. Leviton 49014-J24
    - b. Hubbell
    - c. Amp
    - d. Panduit
    - e. or equal

### 202 FIBER CABLE TERMINATION DEVICES AND RELATED:

- A. Fiber Optic Connectors and Related:
  - 1. General
    - a. Connectors to comply with:
      - 1) EIA/TIA-4750000-C
      - 2) EIA/TIA-604-3A
  - 2. Fusion Splice System
    - a. Insertion Loss:
      - 1) =0.03 dB - manufacturer's rating for typical splice - multimode

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- 2) =0.06 dB - manufacturer's rating for typical splice - singlemode.

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- b. Manufacturer
  - 1) Corning Cable Systems Model X77 Micro Fusion Splicer
  - 2) AFL Telecommunications.
  - 3) or equal.
- 3. Connectors:
  - a. LC with manufacturer installed fiber pigtails unless otherwise noted or scheduled. Contractor to fusion splice the supplied pigtail to the fiber backbone cabling installed under the work of this Project.
  - b. Connector performance per TIA- 568.C.3 and the following.
    - 1) Insertion Loss:
      - (a) Multimode:
        - (1) Less than or equal to 0.75 dB per mated pair
      - (b) Singlemode, Ultra Polish
        - (1) Less than or equal to 0.75 dB per mated pair
      - (c) Singlemode, Angle Polish
        - (1) Less than or equal to 0.30 dB per mated pair
    - 2) Return Loss
      - (a) Singlemode, Ultra Polish, greater than or equal to 55 dB
      - (b) Singlemode, Angle Polish, greater than or equal to 65 dB
    - 3) Manufacturer, Connector
      - (a) Corning Cable Systems
      - (b) AMP
      - (c) Commscope/Systimax
      - (d) Hubbell
      - (e) Leviton
      - (f) Ortronics
      - (g) or equal.
- B. Fiber Distribution Panels, Splice and Patch.
  - 1. Drawing References:
    - a. \*\*\* FPP, Fiber Patch Panel where \*\*\* refers to the minimum potential fiber port count accommodated in the specified assembly. Refer to the single lines for the quantity of strands to be terminated under the work of this Project.
  - 2. Features/Functions/Performance:
    - a. 19" EIA rack mount.
    - b. Suitable for housing fiber optic mechanical splices in a neat and orderly fashion.
    - c. Stores a minimum of one meter of cable without kinks or twists.
    - d. Suitable for use with connectors with manufacturer supplied fiber pigtails as required herein above, fusion spliced to building and outside plant backbone cabling.
    - e. Provides individual strain relief for each splice.
    - f. Suitable for reentry, if required for future maintenance or modification, without damage to the cable or splices
    - g. All required splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors shall be provided.
    - h. Incorporates cable tie downs and routing rings.
    - i. Quick-Release Hinges - Spring loaded quick release hinges enable easy removal of front and rear doors for complete access to fiber connections
    - j. Enhanced Labeling - Label virtually any port configuration hinged labels. The labels hang on the front door for improved visibility. When the door is opened, labels flip down allowing ready viewing of the label and corresponding ports.
    - k. Rotating Grommets - Rotating grommets facilitate loading and retention of jumpers and fiber while minimizing microbending stress when using the slidingtray.
    - l. Complete Access - Management tray has a positive stop in both front and rear working positions providing complete access for moving, adding, changing, or

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- m. Maximum Capacity - Enables a maximum amount of fibers to be patched or patched and spliced in a 2, 3, and 4 RMS enclosure without compromising the accessibility. This allows more efficient utilization of rack space.
- n. Top and bottom access holes located at the rear of the enclosure allow fibers to be routed between tandem enclosures without having to run fibers outside of the enclosure.
- o. Color coded front panel patch connector - color yellow at singlemode strands and color blue at multimode strands. Provide manufacturer's blank cover inserts at unused openings.
- p. High Density - FPP can terminate between 18 to 36 strands per rack unit. Higher density assemblies not acceptable unless otherwise indicated on the plans.
- 3. Manufacturer:
  - a. Corning Cable Systems Pretium Connector Housing (PCH) with splice trays, strain relief and Closet Connector Housing (CCH) inserts as required.
  - b. Leviton OptX
  - c. Hubbell OptiChannel FCR Rack Mount Enclosures with FSP Adapter Panels as required.
  - d. Panduit
  - e. Ortronics
  - f. Commscope/Systimax
  - g. or equal.

### PART 3 EXECUTION

#### 3.01 GENERAL

- A. Refer to Section 27 13 00 - Communications Indoor Backbone Cabling for requirements for termination of Riser and Outside Plant Cabling within Communications Rooms
- B. Refer to Section 27 10 00 - Structured Cabling, Basic Materials and Methods and Section 27 15 00 - Communications Horizontal Cabling.

### Communications Termination Blocks And Patch Panels - 271119

**END OF SECTION**

## SECTION - 271123 COMMUNICATIONS CABLE MANAGEMENT

### PART 1 GENERAL

#### 1.01 SCOPE OF WORK

- A. Innerduct
  - 1. Inside buildings
  - 2. At outside plant
- B. Cable Management at Communication Room Backboards
- C. Cable Management at rack mounted Patch Panels, including provision of cable management for cabling installed under the work of this Project as well as for District furnished patch cords at equipment racks

#### 1.02 RELATED WORK IN OTHER SECTIONS

- A. Section 27 05 33 - Conduits and Backboxes for Communications Systems
- B. Section 27 05 36 - Cable Trays for Communications Systems
- C. Section 27 05 39 - Surface Raceways for Communications Systems
- D. Section 27 05 53 - Identification for Communications Systems
- E. Section 27 10 00 - Structured Cabling, Basic Materials and Methods
- F. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
- G. Section 27 11 19 - Communications Termination Blocks and Patch Panels
- H. Section 27 13 00 - Communications Interior Backbone Cabling
- I. Section 27 14 00 - Communications Outside Plant Backbone Cabling
- J. Section 27 15 00 - Communications Horizontal Cabling

#### 1.03 REFERENCES

- A. American Society For Testing and Materials (ASTM)
  - 1. ASTM D2239-03 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- B. Underwriters Laboratories (UL)
  - 1. UL 910 Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air (Nov. 1998)

#### 1.04 SUBMITTALS

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Procedures: In accordance with Division 1 and Section 27 10 00 - Structured Cabling, Basic Materials and Methods.

#### 1.06 SEQUENCING

- A. Not Used.

### PART 2 PRODUCTS

#### 201 INNERDUCT

#### Communications Cable Management - 271123



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- A. Innerduct, Single Chamber
  - 1. Drawing and spec reference(s):
    - a. ID\*, Innerduct ("\*" denotes cross sectional area of innerduct referenced to standard conduit trade size).
    - b. IDP\*, Innerduct, Plenum ("\*" denotes cross sectional area of innerduct referenced to standard conduit trade size).
  - 2. Construction:
    - a. Selected product suitable for:
      - 1) underground installation in ductbank,
      - 2) plenum (IDP)
      - 3) exposed, in interior utility rooms where indicated.
    - b. High density polyethylene.
    - c. Ribbed or similar exterior construction to resist crushing surface to promote fiber cable installation.
    - d. Provides an interior chamber with a capacity equal to a trade size conduit referenced above.
  - 3. Approvals:
    - a. ASTM D2239(1985) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
    - b. IDP - UL Standard Test Method 2024 of UL 910.
  - 4. Manufacturers, ID in underground ductbanks:
    - a. Carlon Optic-Gard/PE.
    - b. Arnco.
    - c. Vikimatic.
    - d. or equal.
  - 5. Manufacturers, ID in interior, non-plenum applications:
    - a. Carlon Optic-Gard/PVC.
    - b. Arnco.
    - c. Vikimatic.
    - d. or equal.
  - 6. Manufacturers, IDP:
    - a. Carlon Plenum-Gard.
    - b. Arnco.
    - c. Vikimatic.
    - d. or equal.
- B. Innerduct, UV Rated
  - 1. Drawing Reference: ID, UV Rated\*, where "\*" denotes cross sectional area of each chamber referenced to standard conduit trade size).
  - 2. Approvals:
    - a. ASTM D2239(1985) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
  - 3. Construction.
    - a. Listed for UV exposure.
  - 4. Manufacturers:
    - a. Tamaqua Plus II Series Telecom Duct.
    - b. Allwire Black AllDuct.
    - c. or equal.
- C. Woven Mesh Innerduct

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1. Drawing Reference: MID, WMID
2. Features/Functions
  - a. Three inch wide woven mesh assembly contains at least three continuous pullable sleeves, each can accommodate a cable of at least 1" diameter.
  - b. Systems providing fewer than 3 integrally woven sleeves per WMID assembly not acceptable.
  - c. Includes color coded pull tape in each sleeve.
  - d. Pre-Lubricated for cable pulling
  - e. Non-Hydroscopic
  - f. 2500 Pound Tensile Strength
  - g. 480 degree melting point.
  - h. At least 5 years prior field use including at least 25 million feet of product in use.
  - i. Provide plenum rated assembly at plenum locations as defined by the National Electric Code.
3. Manufacturers:
  - a. Maxcell/TVC
    - 1) 2" 2-cell
    - 2) 3" 3-cell in three unique colors per duct.
  - b. or equal (No known equal with identical 3 sleeves woven into a single assembly nor equal industry usage).

### 202 PATCH PANEL CABLE MANAGEMENT

- A. Patch Panel Wire Management, Rack Mounted, Double Sided, Snap Cover.
  1. Drawing References:
    - a. 1 RU Version: RMWM1C
    - b. 2 RU Version: RMWM2C
  2. Construction
    - a. EIA 310-D 19" Rack Mount.
    - b. Continuous flexible system of T shaped fingers and slots along top and panel, deburred to avoid snagging patch cord jacket. Fingers meet the requirements of UL 94V-0 flammability rating.
    - c. Wire management is provide to both front and rear of managers.
    - d. Contoured front door with snap-hinges swings 180 degrees up or down and stays in the open position while cabling.
    - e. Covers and panel have a black powder-coat textured finish,
      - 1) reducing fingerprints and smudges
  3. Capacity
    - a. 1 RU - accommodates at least 20 Cat 6 patch cords.
    - b. 2 RU - accommodates at least 53 Cat 6 patch cords.
  4. Manufacturers - 1 RU
    - a. Chatsworth 30529-719
    - b. B-Line
    - c. Panduit
    - d. Siemon
    - e. Ortronics
    - f. or equal.
  5. Manufacturers - 2 RU
    - a. Chatsworth 30530-719
    - b. B-Line

- c. Panduit
- d. Siemon
- e. Ortronics
- f. or equal.

## **203 BACKBOARD CABLE MANAGEMENT**

- A. Fiber Management Ring, Preformed Loop
  - 1. Drawing Reference: FMR
  - 2. Construction:
    - a. 24 inch diameter steel ring stores fiber slack using Velco fasteners at regular intervals around ring.
    - b. Screw fastens to backboard at BDF or IDF.
  - 3. Manufacturer
    - a. Leviton 48900-OFR
    - b. Panduit
    - c. or equal.
- B. Wire Management Rings, Wall/Ceiling Mounted:
  - 1. Drawing References/Functions Features:
    - a. WMRB - Bridle Ring Type, Threaded Lag Screw
    - b. WMRC - Closed Ring, U shaped assembly with two screw holes at ends,
    - c. WMRO - Open, Re-enterable Split Ring permitting cables to be inserted midspan, two screw holes at ends
    - d. WMP\*\* - Steel back board with 4 inch deep min, 8 inch wide vertical wire management rings, front enterable. Provide trough at bottom of each column of WMP.
    - e. WMP\*\*T - Narrow, steel back board with 4 inch deep min, 3 inch wide vertical wire management rings, front enterable.
  - 2. Provide as required to support indicated cable bundle and location.
  - 3. Provide type WMRB at wood frame construction for cable hung from underside of ceiling, unless otherwise noted.
  - 4. Manufacturers:
    - a. WMRB:
      - 1) B-Line Fasteners, BR Series
      - 2) Senior Industries
      - 3) T&B
      - 4) or equal.
    - b. WMRC
      - 1) Chatworth Products 12127 and 10812 2" and 3" Wall Mount Closed DRing.
      - 2) Senior Industries
      - 3) or equal.
    - c. WMRO
      - 1) Chatworth Products Wall Mount 12035 Open Ring.
      - 2) AllenTel
      - 3) Commscope/Systimax, Inc.
      - 4) Siemon
      - 5) or equal.
    - d. WMP
      - 1) Siemon S188-\*\*\* to match adjacent terminal blocks with S188-WD
      - 2) Ortronics OR-806003194 or OR-806003196 to match terminal blocks.

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- 3) By any manufacturer listed for 110TB under Section 27 11 19 - Communications Termination Blocks and Patch Panels
- 4) or equal.
- e. WMP\*\*T
  - 1) Siemon S110M-WM-\*\*\* to match adjacent terminal blocks
  - 2) By any manufacturer of listed for 110TB under Section 27 11 19 - Communications Termination Blocks and Patch Panels
  - 3) or equal.

### PART 3 EXECUTION

#### 3.01 INNERDUCT INSTALLATION

- A. Schedule of Application
  1. Underground, at Covered Walkways and Above Roof
    - a. Provide WMID at new and existing ducts used by the work of this project. Provide the WMID in sufficient quantity at each segment to place the indicated fiber cabling plus 1 spare cells. Example: Where the plans indicate provision of 3 OSP fiber cables in a ductbank segment, provide at least two 3-cell WMID.
    - b. Place fiber cabling and UTP5e-OP meeting the maximum diameter requirements of the WMID manufacturer inside WMID.
      - 1) Each fiber cable to be allocated its own WMID cell.
      - 2) At Contractor's option, combine multiple UTP5e-OP cables in a single WMID cell up to the manufacturer's recommended fill limit.
    - c. Omit spare cells at 2" duct and conduit. Provide 2 cell WMID.
    - d. Omit WMID at conduits smaller than 2"
  2. At tray conditions and at backboard, cable runway and tray conditions at communications closets, protect fiber cabling with ID Innerduct.
  3. At plenum tray conditions, provide IDP.
  4. At 2" and larger interior conduits, provide riser or plenum rated WMID as applies when installing backbone cabling.
    - a. Provide the WMID in sufficient quantity at each segment to place the indicated cabling plus 3 spare cells. Example: Where the plans indicate provision of 3 fiber cables in a conduit, provide at least two 3-cell WMID.
    - b. Omit spare cells at 2" duct and conduit. Provide 2 cell WMID.
    - c. Omit WMID at conduits smaller than 2" or for conduits used exclusively for horizontal/interior station cabling.
    - d. Provide plenum rated WMID at plenum conditions.

#### 3.02 GENERAL

- A. Refer to Section 27 13 00 Communications Indoor Backbone Cabling for requirements for cable routing within Communications Rooms.

**END OF SECTION**

**SECTION 271500**  
**COMMUNICATIONS HORIZONTAL CABLING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. The horizontal link portion of the cabling system specified in this section extends from the jack termination of the cable at the Work Area Outlet (WAO) faceplate to its patch panel jack termination in its assigned IDF (TR). It also applies to the voice cross-connect system described below.
- B. Section includes, but is not necessarily limited to provision of:
  - 1. Horizontal Station Cabling
    - a. Horizontal copper station cabling, meeting ANSI/TIA Category 6 and ANSI/TIA Category 6A standards, homerun from receptacles to indicated IDF or MDF. Terminated on rack mounted patch panels, as indicated.
  - 2. For all cabling:
    - a. Terminate on patch panels as specified in Section 27 11 19.
    - b. Test cabling to demonstrate performance to specified standards or better using test equipment and methods as specified in Section 27 10 00.
    - c. Label cables, jacks, plates and patch panels as specified in Section 27 05 53.
    - d. Document on Record Documents as described in Section 27 05 00.
- C. Related Documents:
  - 1. Specification Section 27 05 00 - Common Work Results for Communications applies to this Section.
- D. Related Work in Other Sections:
  - 1. Section 27 05 29 - Hangers and Supports for Communications Systems
    - a. J-hooks and hangers for the work of this Section
  - 2. Section 27 05 33 - Conduits and Backboxes for Communications Systems
    - a. Empty raceway for the work of this Section.
  - 3. Section 27 05 36 - Cable Trays for Communications Systems
    - a. Empty tray for the work of this Section.
  - 4. Section 27 05 39 - Surface Raceways for Communications Systems
    - a. Empty raceway for the work of this Section.
  - 5. Section 27 05 53 - Identification for Communications Systems
    - a. Labeling systems and execution for the work of this Section.
  - 6. Section 27 11 19 - Communications Termination Blocks and Patch Panels
    - a. Specification for patch panels and blocks used by work of this Section
  - 7. Section 27 11 23 - Communications Cable Management
    - a. Specification for innerduct, backboard and patch cord management used by the work of this Section.

**1.02 REFERENCES**

- A. As listed in Section 27 10 00.

**1.03 SUBMITTALS**

- A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

**1.04 DELIVERY, STORAGE AND HANDLING**

- A. Procedures: In accordance with Division 1 and Section 27 10 00 - Structured Cabling, Basic Materials and Methods.

**1.05 SEQUENCING**

- A. Coordinate the installation of the horizontal cabling with the other work of this Project, or Projects simultaneously in progress in each building of the project. The Contractor shall ensure

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that construction and preparation of the rooms and spaces in which the work of this Section are to be installed are sufficiently complete before beginning work.

- B. Removal, replacement and re-installation of communications materials and equipment required to permit the completion or correction of other building trade work that is the work of this Project shall be done at no cost to the District or impact to the project schedule.

## **PART 2 PRODUCTS**

### **201 COPPER STRUCTURED CABLING SYSTEMS**

- A. General
  - 1. Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA/EIA-568-C
- B. Definitions
  - 1. Keystone Opening: A communications industry standard rectangular opening in a wall plate or patch panel having nominal dimensions of 0.58" wide and .76" high and designed to securely mount industry standard keystone jacks.
- C. Intervendor compatibility
  - 1. Keystone Jack Compatibility test.
    - a. Any jack or panel system proposed as meeting the keystone compatibility requirements of this specification shall be able to interchangeably mount or mount in (as applies) Leviton Quickport series components.
    - b. Systems exhibiting excess play, inability to insert, inability to remove, damage to the plate or jack or occupying excessive area behind the plate opening will not be accepted.

### **202 COPPER CABLING, CATEGORY RATED DATA/VOICE**

- A. General
  - 1. Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with ANSI/TIA-568-C

### **203 COPPER CABLING, CATEGORY RATED DATA/VOICE**

- A. High Speed, ANSI/TIA Category 6 Cabling
  - 1. Drawing Reference: \*\* UTP6-4, where \*\* denotes cable count
  - 2. Construction:
    - a. Provide horizontal copper cable in accordance with:
      - 1) ANSI/TIA-568-C.2,
      - 2) UL 444
      - 3) NEMA WC 66 (Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pair)
      - 4) ICEA S-90-661
    - b. UTP (unshielded twisted pair),
    - c. 100 ohm impedance
    - d. Four each individually twisted pair, 22 or 24 AWG conductors,
      - 1) Color code:
        - (a) Pair 1 White/Blue Blue
        - (b) Pair 2 White/Orange Orange
        - (c) Pair 3 White/Green Green
        - (d) Pair 4 White/Brown Brown
    - e. No shield in the sheath.
    - f. Jacket
      - 1) Thermoplastic jacket
      - 2) Color: Green unless otherwise indicated.
      - 3) Cable imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 2 feet.

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- 4) The word "FEET" or the abbreviation "FT" shall appear after each length marking.
  - 5) Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70.
  - 6) Type CMP and CMR may be substituted for type CM or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70.
3. Certification
  - a. Warranted by the manufacturer to provide Category 6 performance when installed in accordance with applicable ANSI/TIA standards and when terminated with the jacks supplied by the Contractor for this Project.
4. Performance
  - a. Assembly electrically meets or exceeds ANSI/TIA 568-C.2 Category 6 performance standards
5. Manufacturers:
  - a. Berk-Tek LANmark-6 or LANmark-1000
  - b. Amp
  - c. Belden/CDT
  - d. Commscope/Systimax
  - e. Commscope/Uniprise
  - f. General Cable
  - g. Hitachi
  - h. Mohawk/CDT
  - i. NORDX/CDT
  - j. Superior/Essex
  - k. or equal
- B. High Speed, Category 6 Cabling, Plenum Rated
  1. Drawing Reference:\*\* UTP6-4P, where \*\* denotes cable count
  2. Construction:
    - a. As for non-plenum, with fire retardant overall jacket construction.
    - b. National Safety Agency - UL or ETL listed, NEC compliant for plenum installation.
  3. Manufacturers
    - a. As for non-plenum Cat. 6, plenum construction.
- C. High Speed, Category 6 Cabling, Outside Plant
  1. Drawing Reference: \*\* UTP6-4OP or UTP6-OSP, where \*\* denotes cable count.
  2. Construction:
    - a. Exceeds TIA/EIA 568-C.2 CAT 6, ISO/IEC 11801:2002 CAT 6, & IEC 61156-5 CAT 6 Horizontal Cable
    - b. Suitable for placement in duct below grade subject to extended exposure to standing water. Cable includes flooded construction for moisture protection.
    - c. Jacket: Water resistant linear low density polyethylene or equivalent construction.
    - d. Inner jacket: Water resistant linear low density polyethylene or equivalent construction.
    - e. Insulation: Solid polyolefin or equivalent construction.
    - f. Filling Compound: 80 degree centigrade extended thermoplastic rubber or equivalent construction.
  3. Listing: At least Type CM.
  4. Manufacturer
    - a. Mohawk VersaLAN OSP Category 6
    - b. BerkTek
    - c. CommScope
    - d. General/Essex.
    - e. Belden.
    - f. or equal.

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- D. High Speed, Category 6A Cabling, Plenum Rated
  - 1. Drawing Reference:\*\* UTP6A-4P, where \*\* denotes cable count
  - 2. Construction
    - a. Cable construction shall be four twisted pairs of 24 AWG insulated solid conductors.
    - b. Fire-retardant overall jacket construction meeting NFPA 70 CMP listing.
    - c. UL listed, NEC compliant for plenum installation.
    - d. Cable shall be manufactured with an "X"-shaped pair-divider along the center to maintain separation of individual pairs.
    - e. Conductor diameters shall be 0.0224" .0003" solid copper.
    - f. Conductor insulation diameter shall be 0.039" .0005" fluoro copolymer.
    - g. Twist lay of each pair shall vary in a manner to optimize noise immunity and minimize crosstalk.
    - h. UL or ETL agency certification or verification markings shall be marked on the cable jacket according to the certifying agency's requirements.
    - i. Color coding of the pairs shall be as follows:
      - 1) Pair 1: White/Blue; Blue
      - 2) Pair 2: White/Orange; Orange
      - 3) Pair 3: White/Green; Green
      - 4) Pair 4: White/Brown; Brown
  - 3. Performance Requirements
    - a. All transmission performance parameters shall be independently verified by a UL or ETL third party testing organization.
    - b. Cable shall exceed Category 6A transmission requirements specified in ANSI/TIA/EIA-568-C.2, and shall be tested through 550 MHz.
    - c. Worst case electrical performance characteristics shall be as follows:
    - d. Characteristic Impedance: 100 + 15 Ohm (1.0-100 MHz) 100 + 20 Ohm (101-250 MHz)
    - e. Maximum Conductor Resistance: 9.38 ohm /100 Meters @ 20°C
    - f. Maximum Resistance Unbalance: 3%
    - g. Maximum Mutual Capacitance: 5.6 nF/100 Meters @ 1 kHz
    - h. Maximum Capacitance Unbalance: 330 pF/100 Meters
    - i. Maximum Delay Skew: 25 ns/100 Meters
    - j. Cable shall be UL and c (UL) listed.
    - k. Cable shall exceed IEEE 802.3 DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
  - 4. Environmental Minimum operating conditions meet or exceed:
    - a. Installation: 0°C to +50°C
    - b. Operation: -10°C to +60°C
  - 5. Jacket color:
    - a. Yellow
  - 6. Manufacturers:
    - a. BerkTek LANmark-10G2 Plenum
    - b. Belden 10GX Plenum
    - c. Commscope/Systimax 360 GigaSPEED X10D 2091Plenum
    - d. General GenSpeed 10MTP Plenum
    - e. Mohawk Giga LAN 10 Plenum
    - f. Superior/Essex 10Gain XP Plenum
    - g. or equal
- E. High Speed, Category 6A Cabling, Riser Rated
  - 1. Drawing Reference:\*\* UTP6A-4, where \*\* denotes cable count
  - 2. Construction:
    - a. As for plenum, but with manufacturer's riser rated jacket construction.
    - b. National Safety Agency - UL or ETL listed, NEC compliant for riser installation.
  - 3. Manufacturers



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- a. As for plenum Cat. 6A, riser construction.
- F. High Speed, Cat 6A Cabling, Outside Plant
  - 1. Drawing Reference:\*\* UTP6A-4OP, where \*\* denotes cable count
  - 2. Minimum Features, Functions, Construction:
    - a. Pair Count: 4
    - b. Conductor: Solid annealed copper
    - c. Insulation: Polyolefin
    - d. Separator: CAT 6A: Polyolefin cross-web
    - e. Inner Shield: Electrically continuous 0.008 in (0.20 mm) polymer coated smooth aluminum tape shield, applied with an overlap
    - f. Dry Water Block: SAP powder
    - g. Jacket Black, sunlight and weather resistant polyethylene
    - h. Characteristic Impedance : Ohms  $100 \pm 15$
    - i. Nominal Velocity of Propagation %: CAT 6A: 68
    - j. Performance Compliance
      - 1) ANSI/TIA-568-C.2. Meets Category 6A
      - 2) ANSI/ICEA S-107-704-2012
      - 3) RoHS-compliant/RoHS 2-compliant
      - 4) REACH-compliant
    - k. Max Diameter: less than .4"
  - 3. Environmental
    - a. Operation: -40°F to +167°F (-40°C to +75°C)
    - a. Suitable for installation in underground ductbank
  - 4. Manufacturer:
    - a. Superior Essex BBDN6A
    - b. Or equal (no known equal).

### 204 WORK AREA OUTLETS

- A. Data Jacks Performance Requirements, General
  - 1. Jack
    - a. Construction:
      - 1) High impact, flame retardant UL-rated 94V-0 thermoplastic.
      - 2) The jack shall be designed with an integral locking mechanism which, upon insertion of a modular plug, provide maximum pullout strength at the plug/jack interface.
      - 3) Industry standard keystone construction.
    - b. Performance - The jack shall meet or exceed the following standards.
      - 1) TIA/EIA 568C.1
      - 2) UL listed
      - 3) FCC Part 68, Subpart F
      - 4) Electrical - The modular jacks shall meet the following electrical performance and certification requirements.
        - (a) Insulation resistance - 500 MO maximum
        - (b) Dielectric withstand voltage
        - (c) 1000 VAC RMS, 60 Hz minimum, contact to contact
        - (d) 1000 VAC RMS, 60 Hz minimum to exposed conductive surface
        - (e) IEEE and Cisco Power over Ethernet power dissipation standards.
        - (f) Contact Resistance - 20 mO maximum
        - (g) Current Rating - 1.5 amps at 68 degrees F (20 degrees C) per IEC Publication 512-3, Test 5b.
      - 5) Physical - The modular jacks shall meet the following physical requirements.
        - (a) Connector-insulation displacement connectors accepting 22 and 24 gauge AWG solid conductor wire.

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- (b) Jack wires-square copper alloy wires with 50 micro-inch lubricated gold plating over 100 micro-inch nickel plate
      - (c) Stamped crossover lead frame conductor paths
      - (d) Wired to meet EIA 568C.1 and T568B Color Code
    - 6) Color:
      - (a) Jacks: Green
      - (b) Blank jack cover: To match plate.
      - (c) "C6" or equivalent molded on face of jack.
    - 7) Mechanical - The modular jacks shall meet the following mechanical requirements
      - (a) Plug insertion - minimum 750 plug insertions
      - (b) Contact Force - 100 grams minimum using FCC-approved modular plugs
      - (c) Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack
      - (d) Temperature Range: -40 to 150 degrees F
    - c. Blank connector modules.
      - 1) Features.
      - 2) Snaps into faceplate, fills blank openings.
  - 2. Manufacturers - Jacks, subject to keystone interchangeability requirement:
    - a. Leviton eXtreme 6+ Connector
    - b. Panduit Netkey Keystone Jacks
    - c. Hubbell NextSpeed Xcelerator
    - d. ADC/Krone
    - e. AMP SL Series - 1375187 Category 6 jack.
    - f. Hellerman-Tyton Megaband
    - g. Ortronics Keystone.
    - h. 3M
    - i. Siemon Max 6 MX5-K series
    - j. or equal.
  - 3. Manufacturers - Blank Module.
    - a. Leviton SnapIn Blank Module
    - b. Hubbell SFB
    - c. equal by listed jack manufacturers
    - d. or equal.
- B. Category 6A Data Jacks Performance Requirements, General
- 1. Construction:
    - a. Category 6 Jacks shall be standard FCC-compliant 8-position, un-keyed RJ-45 style, with snap-in mounting features.
    - b. Jacks shall be designed for 4-pair, 100 ohm balanced and unshielded twisted pair (UTP) cables.
    - c. Jacks shall be a two-piece construction, consisting of a zinc die cast body and zinc die cast pre-termination module.
    - d. Jack body and pre-termination module shall have integral molded thermoplastic insulators to form the mating interface, isolate and maintain proper contact locations, and to suppress crosstalk (NEXT/FEXT).
    - e. Jack die cast body shall have an integral male spade connector for connecting a ground jumper wire.
    - f. Jack die cast body shall have features to anchor and strain relieve the cable jacket, and to bond the shield and drain wire to ground.
    - g. The die cast/plastic pre-termination module shall have two levels of wire positioning, with wire management features that provide both strain relief and specific orientation.
    - h. The orientation and positioning of the wire management features shall be designed to optimize crosstalk (NEXT/FEXT) performance and alien crosstalk (ANEXT/AFEXT) performance.

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- i. The die cast pre-termination module shall be removable to permit re-termination of the jack.
- j. Termination method for the jack shall require no special tools.
- k. Each jack shall be single unit construction.
- l. Jack housings shall be a zinc die cast metal construction.
- m. Jacks shall have a temperature rating of -10 °C (14° F) to 70°C (158°F).
- n. Jacks shall utilize a printed circuit board to control near-end crosstalk (NEXT).
- o. Assembled jack design shall incorporate suppression of alien cross-talk (ANEXT) in compliance with ANSI/TIA/EIA-568-C2 requirements.
- p. Jack housings shall fully encase and protect printed circuit board and IDC contact fields.
- q. Jack RJ-45 contacts shall accept a minimum of 2000 mating cycles without degradation of electrical or mechanical performance.
- r. RJ-45 contacts shall maintain a minimum deflection force of 100 grams while mated with an FCC-standard RJ-45 plug.
- s. Contacts shall be formed flat for increased surface contact with mated plugs.
- t. Contacts shall have an inversely oriented right-angle orientation to maximize crosstalk (NEXT/FEXT) and alien crosstalk (ANEXT/AFEXT) performance.
- u. Contacts shall be constructed of Beryllium copper for maximum spring force and durability.
- v. Contact plating shall be a minimum of 50 micro-inches of hard gold in the contact area over 50 micro-inch of nickel.
- w. Jack termination method shall utilize industry standard 110 IDC wire termination, using standard parallel jaw pliers to engage the pre-termination module to the die cast housing.
- x. IDC contacts in the jack body shall be arranged in staggered arrays of 4 sets of 2 contacts to suppress NEXT and ANEXT.
- y. Jacks shall have the Category 6 designation, visible from the front when installed.
- z. IDC contacts shall be Phosphor Bronze with 100 micro-inch tin lead 60/40 plating over nickel.
- aa. Jacks shall terminate 24-22 AWG solid conductors.
- ab. Jacks shall terminate insulated conductors with outside diameters up to .050".
- ac. Jacks shall not require special cords, specialty tools or special installation requirements.
- ad. Jacks shall have attached wiring instruction labels to permit T568B wiring configurations.
- ae. Category 6A jacks shall be lead-free ROHS compliant.
- 2. Performance Requirements
  - a. All transmission parameters shall be independently verified by a UL or ETL third party testing organization. Transmission testing shall be to 625 MHz.
  - b. Category 6A jacks shall exceed transmission requirements specified in ANSI/TIA/EIA-568-C.2.
  - c. Jacks shall be UL LISTED 1863 and CSA certified.
  - d. Jacks shall exceed IEEE 802.3 DTE Power specification to 4 times the rated current limits with no degradation of performance or materials.
  - e. Jacks shall be third party verified to 10 Gigabit Ethernet performance according to IEEE 802.3an.
  - f. Category 6A jacks shall meet or exceed 4-connector channel performance requirements of ANSI/TIA/EIA-568-C.2 standard.
- 3. Blank connector modules.
  - a. Features.
    - 1) Snaps into faceplate, fills blank openings.
- 4. Color
  - a. Jack Color Standards:
    - 1) Yellow

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- b. Blank jack cover: Match plate.
    - 5. Manufacturers - Jacks:
      - a. As for Cat6 with Cat 6A performance
    - 6. Manufacturers - Blank Module.
      - a. As for Cat 6.
  - C. Telecommunications Outlets, Copper Jacks, Wall Mount, Flush
    - 1. Drawing Reference(s):
      - a. MMP4
      - b. MMP6
    - 2. Assembly. Provide complete telecommunications outlet assembly, including but not limited to:
      - a. Faceplate with industry standard keystone openings
      - b. Blank connector modules at faceplate openings not filled with connector modules.
      - c. Labels and label holders.
    - 3. Faceplate.
      - a. Features:
        - 1) Single gang.
        - 2) Front Loading
        - 3) Openings for up to 4 keystone jack connector modules - MMP4, up to 6 openings - MMP6.
        - 4) Flat face faceplates.
        - 5) Label holders with space to label the plate number and the number of each jack.
      - b. Color: To match electrical receptacles and switch plates mounted on same wall,
    - 4. Manufacturers - flat plates, subject to keystone interchangeability requirement:.
      - a. Leviton Quickport Multimedia MOS Single Gang Wall Plates and Adapters.
      - b. Panduit Netkey
      - c. Hubbell InfineStation Series Faceplates and Adapters
      - d. AMP SL Series plates and Adapters
      - e. ADC/Krone
      - f. Hellerman Tyton Modular Faceplates
      - g. 3M
      - h. Ortronics Keystone
      - i. Lutron keystone.
      - j. or equal.
  - D. Duplex Jack Frame, 1 To 4 Receptacles
    - 1. Drawing Reference: DJF4
    - 2. Construction:
      - a. Supports jacks as listed for MMP6 in a duplex electrical opening (NEMA 106 format).
      - b. Modular, with keystone snap-in receptacle options as scheduled.
      - c. Options for 1 to 4 receptacles per plate
      - d. Otherwise as for MMP6 above.
    - 3. Manufacturers:
      - a. Leviton 41087-Q\*P
      - b. Pass & Seymour AC-QP106
      - c. Hubbell.
      - d. Manufacturers listed for MMP6 above
      - e. or equal.
  - E. Voice Telephone, Station Plates & Jack/Receptacles
    - 1. Drawing References:
      - a. Wall Mounted Telephone, Flush:
      - b. 630A
    - 2. Station jacks shall be modular four or 8 wire type and conform to FCC Part 68.
    - 3. Construction, where not otherwise specified, scheduled or indicated:

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- a. Cat 6 Modular as specified above.
  - b. Jack is fully recessed behind plate.
  - c. Spring Wire Contacts, at least 50 microinches gold on 100 microinches nickel.
  - d. Mechanically fastened to Building or Similar. Adhesive fastening not acceptable.
  - e. Stainless Steel or High Strength 94VO plastic.
  - f. Mounts to Single Gang Ring, Single Gang Box or Surface Mounted to Wall or to opening in Surface Raceway - Refer to Schedule on Plans.
  - g. Single Gang Wall Plate with two integral wall telephone mounting studs.
  - h. Insulation displacement (punchdown) termination.
4. Manufacturers, Flush Wall Mounted Wall Telephone.
  - a. Hubbell P630S1GJ8.
  - b. Leviton 4108W-OSP
  - c. or equal using listed plate and jack from one of the listed manufacturers to Category 6 jacks elsewhere herein above.
  - d. or equal.
- F. Modular Furniture Receptacle Plates, 1 To 4 Receptacles, Universal Fit
  1. Drawing Reference: OMP
  2. Construction:
    - a. Modular, with snap-in receptacle options as scheduled.
    - b. Universal fit adjustable latches plate bezel mount fits at least Haworth - Premise, Knoll Ref and Steelcase systems.
    - c. Colors of plates, mounting screws and inserts to be selected by District's Representative.
    - d. Options for 4 jacks per plate.
    - e. Otherwise as for MMP6 above.
  3. Manufacturers:
    - a. As for MMP6
    - b. or equal.
- G. MultiMedia Surface Mount Box
  1. Drawing Reference (s):
    - a. \* MMSB, where \* represents the number of Category connectors of the type specified elsewhere herein.
    - b. Biscuit Box
    - c. Features Functions
      - 1) Surface mount enclosure holds terminated station cabling with Category connectors parallel to face of mounting surface.
      - 2) Mechanically fastened to enclosure surface.
      - 3) 2 part assembly includes fixed mounting base plate and removable cover over terminations
    - d. Manufacturers:
      - 1) Leviton Quickport Surface Mount Boxes
      - 2) Panduit Netkey
      - 3) Hubbell
      - 4) AMP
      - 5) Or equal.

### PART 3 EXECUTION

#### 3.01 SIGNAL POLARITY AND COLOR CODE CONVENTION

- A. Category 6 Station Wire, RJ45 - Per EIA/TIA-568, designation T568B

#### 3.02 STATION CABLE INSTALLATION AND TERMINATION PROCEDURES

- A. General:
  1. All cable runs shall be installed per manufacturer's installation instructions.

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2. Cable installation is "home-run" between the jack termination of the cable at the faceplate to the patch panel jack termination in its assigned IDF (TR).
  - a. Each cable shall be installed without any splices.
  - b. Each cable shall be installed without intermediate termination points unless approved by the District's Representative.
- B. Run Lengths:
  1. Station, Horizontal and IDF Links, Copper:
    - a. The total length of any horizontal station cable from jack termination of the cable at the WAO faceplate to the patch panel jack termination in its assigned IDF (TR) shall not exceed ninety meters (90m) - two hundred ninety-five feet (295') - unless approved by the District's Representative.

### 303 CEILING TILE

- A. Ceiling tile shall be removed as necessary for the cable installation and put back in place without damaging or soiling any of the tiles or supporting framework.
- B. Ceiling tile shall be handled so no fingerprints or marks are left on the tiles, and the tiles are not damaged in any way.
- C. The Contractor is responsible for the cost of repair or replacement of any tile or ceiling tile support/framework hardware that is damaged or soiled by the Contractor..

### 304 WAO HORIZONTAL CABLE PLACEMENT

- A. No cable shall run unsupported by conduit, cable tray, hangers, or other specified support for distances greater than five feet (5').
- B. No cable shall be attached to the suspended ceiling structure or laid directly on the ceiling tiles or hard lid as a means of support, and the bottom of a cable or cable bundle shall be minimum of six inches (6") above the ceiling tile grid.
- C. No cable or cable bundle shall be supported by or attached by any means to fire sprinkler heads, delivery system hardware, environmental sensor system hardware, or the exterior of any conduit, ladder rack, or cable tray. Cable shall be supported by systems specifically installed for cable support.
- D. Where cable being installed is not enclosed in conduit or cable tray, cross all electrical power circuit transport at right angles.
- E. Where discontinuity of cable trays or conduit pathway occurs that causes cable or cable bundle to sag vertically three inches (3") or more, support the cable or cable bundle over the discontinuity using hangers, brackets, hooks, rings, and other applicable supporting devices specified in Section 27 05 29 - Hangers and Supports for Communications Systems.
- F. During placement of cable runs, do not exceed manufacturer's maximum pulling tension or minimum bend radius limits.
- G. Do not bundle cables in cable trays.
- H. Do bundle two (2) or more cables with plenum-rated Velcro ties that are snug but which do not deform the cable geometry as follows:
  1. Whenever cables in cable trays leave the cable tray and enter/exit distribution conduit.
  2. Wherever cables enter a TR. Maintain bundling within the TR.
- I. Manage slack to avoid excess cable or kinking.
- J. Pull new pulling string through all conduits while placing new horizontal cable. Leave a pulling string in the utilized conduits for future use.
- K. Do not roll or store cable reels without an appropriate underlay.
- L. Cables with jackets that are chaffed, burned, have exposed internal conductor insulation, or have any bare copper (shiners) shall be replaced.
- M. After cable installation is complete, tested, and, if necessary, repairs made, install all required fire stopping. The District Representative or his/her designate will not accept the installation as

completed until all required fire stopping has been installed and accepted as complete. See Section 27 05 33 - Conduits and Backboxes For Communications Systems.

- N. Any horizontal cable installed, then removed for any reason, shall not be reused.

**3.05 VOICE CROSS-CONNECT CABLE PLACEMENT**

- A. This cabling system connects 48-port patch panel(s) in each rack to 110 blocks installed adjacent to the voice backbone or riser cable 110 terminations in each TR.
- B. One cable shall be used for each jack in the patch panels. Jack counts are based on copper backbone/riser pair counts. Example: A 100-pair copper riser cable would require two (2) 48-port patch panels, a total of ninety-six (96) jack positions, and four (4) one hundred (100) pair 110 blocks - Reference: 271119-Blocks & Patch Panels.
- C. Bundle voice cross-connect cables separately from horizontal WAO cables. Do not mix with horizontal WAO cables.
- D. Test cable as for station cabling.

**3.06 TERMINATION**

- A. Comply with Section 27 11 19 - Communications Termination Blocks & Patch Panels and the following:
  - 1. Termination of wiring at the station outlet:
    - a. All data and voice station cable shall be terminated at the individual receptacle modules in accordance with EIA/TIA-568-C.
    - b. Termination shall not untwist more than 1/2 inch of cable maximum from the manufactured condition.
    - c. Service loop at WAO
      - 1) Copper. Provide slack, which is to be no less than 2.5" and no greater than 5.0", in the station cable at the station outlet end. This is to allow the Work Area Outlet to be removed from the outlet box and visually inspected without leaving so much wire in the box that it might become accidentally damaged during installation.
    - d. Termination of wiring at existing station outlets:
      - 1) Install in data and voice inserts in place of existing blank insert in existing faceplate.
      - 2) Install new labels and label holders.
  - 2. Termination of copper station wiring at the Telecommunications Room
    - a. For the installation/layout of station cable within the Communications Rooms, see detail on drawings.
    - b. Install one (1) 48-port patch panel for every 48 WAO cables.
    - c. Mount patch panels per the construction drawing set accompanying this Division 27 specification.
    - d. Each patch panel shall have a 2RU horizontal manager (WMP) placed both above and below the panel.
    - e. Horizontal cables are to be routed neatly on overhead cable runway to equipment racks; exit cable runway into equipment rack vertical cable management and proceed to the patch panels.
    - f. Cable termination.
      - 1) Cables on the left side of the patch panel shall enter from the left side vertical cable manager. Cables on the right side of the patch panel shall enter from the right side vertical cable manager. Cables shall not cross the center line of the patch panel.
      - 2) Terminate cables using the 8-pin jack, T568-B four (4) pair termination standard and comply with manufacturer's termination practices, specifications, instructions, and recommendations.
  - 3. Termination of fiber station wiring at the Telecommunications Room
    - a. Fiber station cabling will similarly be terminated on rack mounted patch panels.

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- b. Termination shall begin at the upper left corner of the path panel and proceed to the right continuing down, left to right until all cables are terminated.
- B. Voice cross-connect system termination.
  - 1. 110 cable end termination.
    - a. Mount 110 termination fields per manufacturer's specifications, instructions, and recommendations. Use accompanying construction drawing set to determine mounting locations and configurations.
    - b. 110 C4 blocks shall be used for all but the last position on each twenty-five (25) pair row of a 110 one-hundred (100) pair field and C5 blocks for the last five (5) pair positions in each twenty-five (25) pair row.
  - 2. Patch panel end terminations.
    - a. Install one (1) 48-port patch panel for every 48 cables terminated at the voice cross-connect systems 110 blocks.
    - b. Mount patch panels per the construction drawings Each patch panel shall have a 2RU horizontal manager placed both above and below the panel.
    - c. Terminate cables using the 8-pin jack, T568-B four (4) pair termination standard and comply with manufacturer's termination practices, specifications, instructions, and recommendations.

### **3.07 LABELING**

- A. Cable labels are required on the WAO cables only. Voice cross-connect cables do not require cable labels.
- B. Label placement: Attach a label to both ends of each cable six inches (6") from the cables termination at WAO and TR patch panel port.
- C. Label content and format, both ends of cable shall be XXX - YZZZ where:
  - 1. XXX = the 3-digit building number which is the last 3 digits of the facility asset designator - a 4-digit number called a CAAN number.
  - 2. Y = the floor number - use zero (0) for basement.
  - 3. ZZZ = the WAO jack number the cable is terminated on - 001 through 999.
  - 4. Example: 195-2001 = Building 195, (2) second floor, (001) first jack on the second floor.
- D. All labels shall be machine created labels. Hand labeling is not acceptable.

### **3.08 TESTING, VERIFICATION, ADJUSTMENTS AND ACCEPTANCE**

- A. Comply with Section 27 10 00 - Structured Cabling, Basic Materials & Methods

### **3.09 AS-BUILT DRAWINGS**

- A. Comply with Section 27 05 00 - Common Work Results for Communications

**END OF SECTION**



**SECTION 275225**  
**PORTABLE ASSISTIVE LISTENING SYSTEM**

**PART 1 - GENERAL**

**1.01 SCOPE OF WORK**

- A. Assistive listening system shall be in accordance with CBC Section 11B-219 and shall comply with CBC Section 11B-706.
- B. The work under this section includes all final design, all labor, material, equipment, supplies, labor, testing, and accessories required to furnish and install a complete permanent Assistive Listening System (ALS) as indicated on the drawings and as specified herein.
  - 1. Provide portable receivers in quantities as required in the 2019 California Building Code. Quantity of receivers shall accommodate a minimum of 4% of the total number of seats, but no case less than 2.
  - 2. Twenty-five percent minimum of the receivers but no less than 2 shall be hearing-aid compatible neckloops (per CBC Section 11B-706.3)
  - 3. Where the system provided is limited to specific areas or seats, then such areas or seats shall be within 50-foot viewing distance of, and have a complete view of, the stage or playing area (CBC Section 11B-219.4)
- C. It is the intent of the Drawings and Specifications, which are presented in a "design-build" format, for the Contractor to design, provide and install a complete, fully operational, and tested system.
- D. All miscellaneous system components including, but not limited to, cables, termination equipment, punch blocks, patch panels, backboards, cabinets, power strips, mounts, fasteners, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.
- E. The Assistive Listening System shall include, but not be limited to, the following subsystems / products:
  - 1. See Products Section.

**1.02 RELATED WORK**

- A. Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions and sections of Divisions 1 and 27 of these specifications.
- B. All applicable portions of Section 26 00 00 shall apply to this section as though written herein completely.

**1.03 GENERAL REQUIREMENTS**

- A. The contractor shall hold a valid State of California C-7 Low-Voltage license, shall have completed at least 5 projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at least five years, and capable of being bonded to assure the owner of performance and satisfactory service during the guarantee period.
- B. The contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work.
- C. All work shall be performed under the supervision of a company accredited by the basic equipment manufacturer and such accreditation must be presented.
- D. The installing contractor shall be a factory authorized distributor and warrantee station for the brand of equipment offered and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment.

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- E. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. The Contractor shall also furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.

**1.04 QUALITY ASSURANCE**

- A. In order to maintain a high degree of quality assurance, the Contractor shall, without exception, use the parts and supplies as specified on the drawings and in this specification.

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- B. For any proposed product substitution or when the Contractor intends to include an "or equal" product in the bid pricing, provide a substitution request submittal to the Owner's Project Manager for review no later than fifteen (15) calendar days prior to Bid submittal. This report shall include:
  - 1. Description of how the proposed product(s) will impact meeting the project completion date, indicate item(s) with lead times and expected delivery date(s).
  - 2. Itemized cost comparisons between the proposed product(s) and the listed product(s).
  - 3. Detailed technical analysis of the electrical and mechanical specification differences between the proposed product(s) and the listed product(s).
  - 4. ETL "Verified" or UL "Verified" test lab documentation for the proposed product(s), component(s) and assemblies.
  - 5. Proposed product identification, manufacturer literature (specifications and cut sheets).
  - 6. Name, address and contact information of several similar projects where the proposed product(s) have been used.
  - 7. Name, address and contact information of the proposed product(s) manufacturer's local representative.
  - 8. Sample proposed product(s) manufacturer's warranty.
- C. The Owner's Design Team/Project Manager must approve any proposed product(s) substitution item in writing. The Owner's Design Team/Project Manager reserves the right to require a complete sample of any proposed product(s) and may request a sample tested by an independent testing consultant to prove equality. The decision of the Owner's Design Team/Project Manager regarding equality of proposed product(s) items will be final.
- D. It is a mandatory requirement that a single Contractor perform the work described in this specification.

### 1.05 SUBMITTAL AND MANUAL

- A. Comply with all requirements of the General Conditions, Supplementary Conditions and applicable sections of Divisions 1 and 26 of these specifications.
- B. Additional requirements of this section are:
  - 1. Within fifteen (15) calendar days after the date of award of the Contract, the Contractor shall submit eight (8) copies of the complete submission to the Architect for review.
  - 2. The submission shall consist of five (5) major sections with each section separated with index tabs. Each page in the submission shall be numbered chronologically and shall be summarized in the index.
  - 3. The first section shall be the "index" which shall include the project title and address, name of the firm submitting the proposal and name of the Architect.
  - 4. The second section shall include a copy of the Contractors valid C-7 California State Contractors license, a list of 5 projects of equal or greater scope, and a list of proposed instrumentation to be used by the contractor. In addition, provide a written notice guarantying the provision of the requested warranty.
  - 5. The third section shall contain the comparative specification listing, including a complete listing of the characteristics of the equipment to be furnished next to all of the specified equipment's features and functions as stated in the specifications and data sheets.
  - 6. The fourth section shall contain an original factory data sheet for every component in the specifications.
  - 7. The fifth section shall contain a designation schedule for each Structured Cabling System location and complete 1/8" = 1'-0" scale drawing showing system wiring plans.
- C. Failure to comply with all of the requirements listed above will result in the rejection of the entire submittal package.
- D. The Contractor shall provide two copies of an "Op-erating and Servicing Manual" for the system. The manuals shall be bound in flexible binders. All data shall be printed material or typewritten. Each manual shall include the following: Instruc-tions necessary for the proper operation and servicing of the system; complete as-built installation drawings of the system; wiring

destination schedule for each circuit leaving for each piece of equipment; a schematic diagram of major components with all transistor and IC complements and replacement number.

#### **1.06 GENERAL SYSTEM PRODUCT WARRANTY**

- A. Prior to Owner acceptance, the contractor shall provide to Owner, a manufacturer's product warranty. On behalf of the Owner, the contractor shall submit the required warranty registration form within ninety (90) days of Contractor's purchase. The Owner will only acknowledge acceptance upon submittal of a valid manufacturer's warranty.
- B. The warranty shall commence from the date of final written acceptance by the Owner.
- C. All conditions for obtaining the manufacturers warranty shall be the sole responsibility of the contractor.
- D. The manufacturer shall warrant the transmitter and receivers to be free from defects in workmanship and material under normal use and conditions for the useful lifetime of the product from date of purchase. Useful lifetime is defined as five (5) years from date of purchase. All other products and accessories shall have a one (1) year limited warranty to be free from defects in workmanship and material under normal use and conditions from date of purchase.
- E. Any material showing mechanical or electrical defects shall be replaced promptly at no expense to the Owner.
- F. A typewritten notice shall be posted at the equipment rack(s) that shall indicate the firm, address and telephone number to call when service is necessary. The notice shall be mounted in a neatly finished metal frame with a clear plastic window and securely attached to the inside of the door.

### **PART 2 - SYSTEM EQUIPMENT SPECIFICATION**

#### **201 ACCEPTABLE MANUFACTURERS**

- A. All equipment listed herein will be by Listen Technologies; or approved equal.
- B. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications and the equipment's technical data sheets.
- C. The functions and features specified are vital to the operation of this facility. Therefore, inclusion of a component's manufacturer in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- D. All basic electronic equipment (not including cable) specified herein shall be produced by a single manufacturer of established reputation and experience who shall have produced similar apparatus for at least three or more years and who shall be able to refer to similar installations rendering satisfactory service.

#### **202 SYSTEM FUNCTIONS AND CAPABILITIES:**

- A. The FM wireless ALS is for use by the hearing-impaired.
- B. The ALS system shall be capable of broadcasting on 57 channels and be frequency agile.
- C. The ALS shall have 80 db SNR or greater, end-to-end.
- D. Portable receivers shall be frequency agile and frequency set with a "seek" button and shall incorporate an LCD display that indicates battery status, RF signal strength and channel.
- E. Portable receivers shall incorporate a stereo headset jack that allows the user to plug in either to a mono or stereo headset and listen to the audio normally.
- F. Portable receivers shall incorporate automatic battery charging circuitry for the recharging of NiMH batteries.
- G. Audio signal inputs shall consist of 3.5mm jacks, located in wall or floor boxes as indicated on the plan drawings.

#### **203 PRODUCTS:**

- A. The following is to be used as a GUIDE, and are to be included, but not limited to, in the system(s) to be supplied.

#### **204 LISTEN TECHNOLOGIES LT-700 PORTABLE FM TRANSMITTER**

- A. The portable FM transmitter shall be capable of broadcasting on 57 channels. The unit shall incorporate a microphone sensitivity switch. The device shall broadcast on both wide and narrow band channels with a SNR of 80dB or greater. The device shall have an audio frequency response of 50Hz to 15KHz ( $\pm 3$ dB) at 72MHz, or of 50Hz to 10KHz, ( $\pm 3$ dB) at 216MHz. The device will incorporate a mute switch and the battery door shall be capable of being mechanically locked. The device shall incorporate an LCD display that indicates channel, battery level, low battery, battery charging, and RF signal strength. The portable transmitter shall incorporate automatic battery charging circuitry for the recharging of NiMH batteries, with the ability to charge via a wall transformer or drop in charging case. Each portable transmitter shall come equipped with its own patch cable allowing them to easily interface with the input of a stationary sound system anywhere on campus. Include one (1) line input cable with each portable transmitter. Listen Technologies part number LT-700-072, LT-700-216.
- B. PROVIDE QUANTITY REQUIRED PER 2014 CBC 11B ALS REQUIREMENTS.

#### **205 LISTEN TECHNOLOGIES LR-4200 PORTABLE RECEIVER**

- A. The FM receiver shall be capable of receiving on 57 wide and narrow band channels. The receiver shall tune to a single channel and user shall not be able to change the channel. The receiver shall have a signal-to-noise (SNR) ratio of 80 dB or greater (70dB for the 216MHz models) and shall have an audio frequency response of 50 Hz - 15 kHz ( $\pm 3$  dB). The receiver shall employ a unique DSP SQTM noise reduction technology. The receiver shall have a programmable squelch circuit. The receiver shall incorporate a multi-functional display (OLED) that indicates battery status, inventory number, volume level and customizable channel names. The receiver shall have the option of being lanyard or belt clip worn and the lanyard shall incorporate an integrated neck loop for compatibility with T-coil hearing aids. The receiver shall be intelligent and provide customized audio to either earphones or the integrated neck loop based upon which is connected. The receiver shall have two (2) 3.5 mm (TRRS) connectors to drive the integrated neck loop lanyard or up to two (2) mono or stereo earphones. The receiver shall be fully programmable via supplied software. The receiver shall have a micro USB connector used for programming/setup, inventory control, charging, and firmware upgrades. The receiver shall incorporate automatic battery charging circuitry and use a non-proprietary lithium ion (Li-ion) battery. The receiver shall automatically turn on when removed from the charging device and automatically turn off when returned to the charging device. The receiver shall have additional charging contacts to allow multiply charging options. The receiver shall be covered by a hassle free limited lifetime warranty. Listen Technology part numbers LT-4200-072, LT-4200-216.
- B. PROVIDE QUANTITY REQUIRED PER 2014 CBC 11B ALS REQUIREMENTS.
- C. Listen Technologies LA-166 Neck Loop, for wireless connection to hearing aids equipped with a "T" coil. Provide quantity of 25% of total quantity of receivers.
- D. Listen Technologies LA-164 Ear Speaker, over-the-ear design, single ear clip. Provide quantity 1 per receiver.
- E. Listen Technologies LA-311-01, 16-Unit Charging/Carrying case. Case shall have drop-in charging stations for simultaneous charging of up to 16 portable receivers. Case shall have auto shut-off feature to prevent over-charging receivers. Case shall be hard-sided and lockable. Provide quantity required.
- F. Listen Technologies LA-362 NiMH rechargeable batteries, (2) required per portable device.
- G. Listen Technologies LA-304 Notification signage kit(s), or as directed by Architect. See Architect drawings for quantity.

### **PART 3 - EXECUTION**

#### **301 GENERAL INSTALLATION REQUIREMENTS**

- A. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's wiring diagrams. Should any variations in these requirements occur, the

contractor shall notify the architect before making any change. It shall be the responsibility of the factory-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.

- B. Furnish all conduit, junction boxes, conductors, cables, faceplates, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.
- C. The cables within the rack or cabinets shall be carefully wrapped and strapped with Velcro tie straps. Nylon type "zip ties" or tie-raps are prohibited. All cables shall be numbered for identification at both ends. Cable numbering shall be provided on final as-built drawings.
- D. The contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc., The contractor shall remove all debris and rubbish occasioned by the electronic systems work from the site. The contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., Caused by the performance of this work.
- E. The system must meet all local and other prevailing codes.
- F. The system must meet all 2014 CBC code section 11B-706 Assistive Listening Systems requirements.
- G. The system shall accommodate a minimum of 4 percent of the total number of seats in the required area.
- H. Contractor shall provide Assistive Listening System signage in the quantities and locations as indicated on the architectural drawings, and as required by 2014 CBC and the 2010 ADA Standards.
- I. Prior to ordering equipment, Contractor shall perform a radio frequency (RF) test to determine and identify any potential RF interference. Contractor shall be responsible to select ALS system radio frequencies that do not receive RF interference from other building systems such as lighting, power, generators, HVAC, computers, audio paging, etc. Final system testing shall be conducted with all building systems turned on to verify the ALS system is free of interference. If RF interference is detected within the first 30 days after project completion, contractor shall replace ALS equipment with equipment on another frequency at no additional cost to the owner. Contractor shall include all costs in base bid.
- J. All cabling shall be splice free.
- K. Plenum rated cable may be run exposed above ceilings, provided the cabling is supported independent of other utilities such as conduits, pipes, and the ceiling support systems. The cables shall not be laid directly on the ceiling panels. The use of cable ties shall be done in accordance with the cable manufacturer's requirements. The cable jacket composition must meet local and all other prevailing fire and safety codes.
- L. All firewalls penetrated by structured cabling shall be sealed by use a non-permanent fire blanket or other method in compliance with the current edition of National Fire Protection Association (NFPA) and the California Electric Code (CEC) or other prevailing code. The contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. Contractors who use this method will be required to replace all cables affected and provide the original specified access to each effected area.
- M. Submit block diagram and as-built drawing of all equipment.
- N. 120 volt AC to be supplied by the Electrical Contractor.

### **3.02 GENERAL TESTING REQUIREMENTS**

- A. Provide all instruments for testing and demonstrating in the presence of the owner's inspector that the frequency response is as stated in the factory data sheets. Check all circuits and wiring to verify they are free of shorts and grounds.

**303 3.3 - FINAL ACCEPTANCE**

- A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.
- B. The Owner or Owner's representative will conduct a final job review once the contractor has finished the job. This review will take place within one week after the contractor notifies the owner.
- C. Two copies of all certification data and drawings for all identifications shall be provided to the Owner before the owner's review.
- D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.
- E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing will be billed back to the contractor.
- F. In the event that repairs or adjustments are necessary, the contractor shall make these repairs at his own expense. All repairs shall be completed within 10 days from the time they are discovered.
- G. The contractor shall provide not less than eight (8) hours for site instruction of personnel in the operation and maintenance of the installed systems. This instruction time shall be divided as directed by the Owner.
- H. The contractor shall hand to the owner a copy of any applicable installation specific software configurations in compact disk or USB thumb drive format.

**END OF SECTION**

**Portable Assistive Listening System - 275225**

## **SECTION 281600 - INTRUSION ALARM SYSTEM**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

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

#### **1.02 SCOPE OF WORK**

- A. The work under this section includes all labor, material, equipment, testing, and accessories required to furnish and install a complete Intrusion Alarm System as indicated on the drawings and as specified herein.
- B. It is the intent of the Drawings and Specifications for the Contractor to provide and install a complete, fully operational, and tested system.
- C. All miscellaneous system components including, but not limited to, cables, termination equipment, punch blocks, patch panels, backboards, dedicated power provisions, as well as any other related items, shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.

#### **1.03 GENERAL REQUIREMENTS**

- A. The contractor shall hold a valid State of California C-7 Low-Voltage and Department of Consumer Affairs "Alarm Company Operator's" License, and shall have completed at least 20 projects of equal scope, shall have been in business of furnishing and installing systems of this scope and magnitude for at least five years, and capable of being bonded to assure the owner of performance and satisfactory service during the guarantee period.
- B. The contractor shall hold all other licenses required by the legally constituted authorities having jurisdiction over the work.
- C. All work shall be performed under the supervision of a company accredited by the basic equipment manufacturer and such accreditation must be presented.
- D. The installing contractor shall be a factory authorized distributor and warranty station for the brand of equipment offered and shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment. The installing contractor shall maintain a spare set of all major parts for the system at all times. All system components shall be 100% backed up with stock at contractors shop.
- E. All of the equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. The Contractor shall furnish a letter from the manufacturer of all major equipment, which certifies that the installing contractor is the Authorized Distributor and that the equipment has been installed according to factory intended practices. The Contractor shall also furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.
- F. If applicable, all of the equipment in this specification shall be furnished and installed with the most current software package available at the time of installation. At the time of Owner Acceptance of the installation, all equipment shall include any and all updated software revisions. In addition, when the software is available in disk format, a backup copy of the most up to date revision shall be handed to the Owner at the completion of the project.

#### **1.04 QUALITY ASSURANCE**

- A. In order to maintain a high degree of quality assurance, the contractor shall, without exception, use the parts and supplies as specified in this specification.
- B. For any proposed substitution, a complete descriptive, technical and cost comparison, and test report package shall be submitted to the Owner for review five (5) working days prior to the bid date. Final approval of the substitution item shall be at the option of the Owner, and written notice of the status of the proposed alternative will be supplied to all bidders prior to the final bid

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date. The Owner or its representative must approve any proposed substitution item in writing. The Owner reserves the right to require a complete sample of any proposed equal item and may, if necessary, request a sample tested by an independent testing consultant to prove equality. The decision of the Owner regarding equality of proposed equal items will be final.

- C. It is the intent of these specifications to establish a standard of quality for labor and material to be installed. The Base Bid shall include materials as specified - without exception. Proposed substitutions, if approved in writing by the Owner, shall be listed on the bid form in addition to the specified materials.
- D. Approved equal status does not imply final acceptance. Final acceptance of a substitution item shall be made by the Owner prior to the award of bid to the successful contractor, after reviewing the bid information.
- E. If a substitution item is given final acceptance by the Owner, the Contractor shall reimburse the Architect for any additional engineering charges and shall pay all charges of other trades resulting from the substitution, at no cost to the Owner.
- F. If a substitution item is given final acceptance by the Owner, the contractor shall pay all charges (including travel, lodging, meals, etc...) required to provide factory certification, equal to that of a Factory Authorized Distributor of the substituted item, for two (2) selected Owners representatives. This training shall occur at the primary factory of the substituted item in question and shall allow the selected Owners representatives to provide any and all Factory / Manufacturer Approved repairs, services, software upgrades, etc... without affecting any available or applicable Manufacturer Warranties.

#### **1.05 SUBMITTAL AND MANUAL**

- A. Submittal requirements of this section are:
- B. Within thirty-five (35) calendar days after the date of award of the Contract, the Contractor shall submit eight copies of the complete submission to the Architect for review.
- C. The submission shall consist of five major sections with each section separated with index tabs. Each page in the submission shall be numbered chronologically and shall be summarized in the index.
- D. The first section shall be the "index" which shall include the project title and address, name of the firm submitting the proposal and name of the Architect.
- E. The second section shall include a copy of the Contractors valid C-7 California State Contractors license and ACO license, a list of 20 projects of equal or greater scope, and a list of proposed instrumentation to be used by the contractor. In addition, provide a written notice guarantying the provision of the requested warranty.
- F. The third section shall contain the comparative specification listing, including a complete listing of the characteristics of the equipment to be furnished next to all of the specified equipment's features and functions as stated in the specifications and data sheets.
- G. The fourth section shall contain an original factory data sheet for every component in the specifications.
- H. The fifth section shall contain a designation schedule for each device location and complete 1/8" = 1'-0" scale AutoCAD created drawing showing system wiring plans. The Architect / Engineer will provide AutoCAD format drawings of the original associated plans, upon receipt of a written request from the contractor at no charge.
  - 1. Failure to comply with all of the requirements listed above will result in the rejection of the entire submittal package.
  - 2. The Contractor shall provide two copies of an "Op-erating and Servicing Manual" for the system. The manuals shall be bound in flexible binders. All data shall be printed material or typewritten. Each manual shall include the following:
    - 3. Instructions necessary for the proper operation and servicing of the system.
    - 4. Complete as-built installation drawings of the system.
    - 5. A wiring destination sche-dule for each circuit leaving for each piece of equipment.

6. A schematic diagram of major components and replacement numbers.

**1.06 GENERAL SYSTEM PRODUCT, INSTALLATION AND OVERALL SYSTEM WARRANTY**

- A. Prior to Owner acceptance, the contractor shall provide to Owner, a manufacturers product and performance warranty. This will require a submittal of the required pre-job certification registration forms as well as the required project closing information. The Owner will only acknowledge acceptance upon submittal of a valid manufacturers warranty.
- B. The warranty shall commence from the date of final written acceptance by the Owner.
- C. All conditions for obtaining the manufacturers warranty shall be the sole responsibility of the contractor.
- D. The contractor shall maintain a competent service organization and shall, if requested, submit a service maintenance agreement to the owner after the end of the guarantee period.
- E. A typewritten notice shall be posted at the equipment rack that shall indicate the firm, address and telephone number to call when service is necessary. The notice shall be mounted in a neatly finished metal frame with a clear plastic window and securely attached to the inside of the door.

**1.07 SPECIFIC PRODUCT, INSTALLATION AND OVERALL SYSTEM WARRANTY**

- A. The entire system shall be warranted free of mechanical or electrical defects for a period of one (1) year after final acceptance of the installation. Any material showing mechanical or electrical defects shall be replaced promptly at no expense to the Owner.

**1.08 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer of control panel and associated equipment shall be: Ademco/Honeywell .VISTA 128 BP
- B. Its is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these specifications and the equipment's technical data sheets.
- C. The functions and features specified are vital to the operation of this facility. Therefore, inclusion of a component's manufacturer in the list of acceptable manufacturers does not release the contractor from strict compliance with the requirements of this specification.
- D. All basic electronic equipment (not including cable) specified herein shall be produced by a single manufacturer of established reputation and experience who shall have produced similar apparatus for at least three or more years and who shall be able to refer to similar installations rendering satisfactory service.

**1.09 SYSTEM FUNCTIONS AND CAPABILITIES:**

- A. Input/Output Capacity
- B. This system shall be capable of monitoring a maximum of 128 individual zones and controlling a maximum of 96 output relays.
- C. User/Authorization Level Capacity
- D. The system shall be capable of operation by 150 unique Personal Identification Numbers (PIN) codes with each code having its own custom authority level.
- E. Area System
- F. The user of the system shall be capable of selectively arming and disarming any one or more of 8 areas within the intrusion detection system based on the user PIN code used. Each of the 128 zones shall be able to be assigned to any of the 8 available areas.
- G. The user of the system shall be capable of assigning an opening and closing schedule to all areas within a partition or to each of the 8 areas separately.
  - 1. Keypads
  - 2. The system shall support a maximum of 8 keypads with alphanumeric display. Each keypad shall be capable of arming and disarming any area within its partition based on PIN authorization. The keypad's alphanumeric display shall provide complete prompt

- messages during all stages of operation and programming of the system and display all relevant operating and test data.
3. Communication between the control panel and all keypads and zone expanders shall be multiplexed over a multiconductor cable, as recommended by the manufacturer. This cable shall also provide the power to all keypads, zone expanders, output expanders, and other power consuming detection devices.
  4. The system shall display all system troubles at selected keypads with distinct alphanumeric messages.
  5. The keypad shall include self-test diagnostics enabling the installer to test all keypad functions : display test, key test, zone test, LED test, relay test, tone test, and address test.
  6. Zone Configuration
  7. The system shall have a minimum of eight grounded burglary and two Class B ungrounded 2-wire smoke detector zones available from the control panel. A minimum of 8 Class B ungrounded zones shall be available at each zone expander on the system. The system shall have the capacity for a maximum of 8 keypads and a maximum of fifty 4-zone expanders or 119 single zone expanders. It shall also have the capacity of a maximum of 50 relay output expanders. All Class B zones shall be 2-wire, 22 AWG minimum, supervised by an end-of-line (EOL) device and shall be able to detect open and short conditions in excess of 500ms duration.
  8. Each zone shall function in any of the following configurations: Night, Day, Exit, Supervisory, Emergency, Panic.
    - a. Relay Outputs
  9. The control panel shall have, as an integral part of the assembly, 2 SPDT Form C relays rated at 1 Amp at 30 VDC or 120 VAC, and four 12 VDC outputs rated at 50mA each. It shall also have the capacity of a maximum of 50 output expander modules with 200 switched ground (open collector) outputs, 50mA maximum and 200 auxiliary relays (Form C rated at 1.0 Amp at 24 VDC, .5 Amp at 120 VAC).
  10. Relays and voltage outputs shall be capable of being independently programmed to turn on and off at selected times each day.
    - a. Communication
  11. The system shall be capable of signaling to 2 remote monitoring station receivers, 4 telephone numbers of 32 digits each using 2 separate switched telephone network lines such that if two unsuccessful attempts are made on the first line to the first number, the system shall make 2 attempts on first line to the second number. If these two attempts are unsuccessful, the system shall make two further attempts on the first line of the first number. After the tenth unsuccessful attempt, dialing shall stop and the alphanumeric keypad shall display trouble. Should another event occur that requires a report to be transmitted, the dialing process shall be repeated. The system shall have a programmable option to dial a second set of telephone numbers after the first 10 attempts using the same sequence.
  12. The system shall be capable of communication at 300 baud using the IBM Synchronous Data Link Control format, Modem IIe format, or the Contact ID format.
  13. The system shall be capable of supporting multiplex communication with digital dialer backup, existing ethernet or token ring data networks, satellite communication, fiber optic networks, local area networks, wide area networks, cellular communication, and retail data networks.

## **PART 2 - PRODUCTS**

### **201 GENERAL COMPONENT REQUIREMENTS**

- A. Component Enclosure
- B. Annunciator housings; power supply enclosures, terminal cabinets, control units, and other component housings, collectively referred to as enclosures shall be so formed and assembled as to be sturdy and rigid. If sheet steel is used in the fabrication of enclosures, it shall be not less than 18 gauge door with a 20 gauge box frame. Where exposed pins, the hinges shall be of the tight pin type or the ends of hinge pins shall be tack welded to prevent ready removal.

Doors having a latch edge length of less than 24 inches shall be provided with a single lock. Where the latch edge of the hinged door is 24 inches or more in length, doors shall be provided with three-point latching device with lock; or alternatively with two locks, one located near each end.

1. Electronic Components
  - a. All electronic components of the system shall be of the solid-state type, mounted on printed circuit boards conforming to UL 796.
    - 1) Relays
  - b. Light duty relays and similar switching devices shall be solid-state type or electromechanical.
    - 1) Annunciation Lamps/LED's
  - c. Visual annunciators used on annunciator modules and elsewhere throughout the system shall be light emitting diodes (LEDs or VFDs). Annunciators shall be so connected in the circuit that failure of the annunciator, socket or protective circuitry shall not result in an improper or indeterminate signal. Lamps of varying types, voltage, and wattage shall have bases and sockets that prevent incorrect replacement.
    - 1) Control Designations
  - d. Controls shall be provided to ensure ease of operation of all specified characteristics. Where applicable, clockwise rotation of controls shall result in an increasing function. Controls, switches, visual signals and indicating devices, input and output connectors, terminals and test points shall be clearly marked or labeled on the hardware to permit quick identification of intended use and location.
    - 1) Test Modes
  - e. The system shall include a provision that permits testing from any alphanumeric keypad. The test shall include standby battery, alarm bell or siren, and communication to the central station.
  - f. The system shall include a provision for an automatic, daily, weekly, thirty day, or up to sixty day test of the communication link from the control panel installation site to the central station.
  - g. The system shall include a provision for displaying the condition of the internal system power and wiring. Internal monitors shall include the bell circuit, AC power, battery voltage level, charging voltage, panel box tamper, phone trouble line 1, phone trouble line 2, and transmit trouble.
    - 1) Power Supplies
  - h. Power supplies for the Intrusion Detection System shall operate from 120 VAC, supplied at the respective protected areas. Standby batteries shall be supplied to power the system in the event of a utility power failure. Batteries shall be sized to provide 105% capacity for eight hours. Standby batteries shall be sealed lead-acid. Power supplies shall be all Solid State. Controls shall be designed to maintain full battery charge when alternating current is available. Batteries shall be recharged to 85% capacity within 24 hours from battery use. The system shall be automatically transferred to battery power upon loss of alternating current power and return to alternating current power upon restoration. Intrusion alarms shall not be initiated during switch over; a signal shall be initiated upon failure of battery and/or alternating current power.
    - 1) Control Unit
  - i. The control panel shall be equipped with an anti-reverse circuit breaker to prevent damage due to accidental reversal of battery leads
    - 1) Lightning Suppression
  - j. The system shall include an optional lightning suppresser module that intercepts and directs lightning, transient, and RF interference to ground.
    - 1) Motion Detectors
  - k. Shall be Ademco/Honeywell DT6360STC for ceiling applications and Ademco/Honeywell DT7450 for wall applications.

**C. Cables:**

1. Zone cables shall be, as follows:
  - a. 4 conductor, #22 West Penn 355 2 Shielded for data loop 2 Unshielded for power
  - b. 4 conductor, #22 West Penn AQC 355 for polling loop and power for outdoor and underground applications.
  - c. Door switch wire shall be two #22 West Penn 221 or approved equal. Larger size conductor shall be used when higher mechanical strength is required.
2. Phone line cord shall be North Supply #S-480976 or 8/C standard cable with molded conductor.
3. Power cable shall be 2 #12 for 120 VAC and 2 #18 for 16 VAC.
4. All wire shall meet FR-1 Flame Test and shall be UL listed.
5. All wire and cables shall be indexed with a code marker and identified on a sheet, copy of which shall be left in equipment and placed in as-built data.
  - a. All wire and cables shall be installed in raceway.
6. Two screw terminal strips with box wire clamps shall be Beau C-15 series pressure contact terminal blocks.

**202 SPECIFIC TESTING REQUIREMENTS:**

- A. See Section 3 for general testing requirements.

**PART 3 - EXECUTION**

**301 GENERAL INSTALLATION REQUIREMENTS**

- A. Motion detectors shall be "on" at all times, unless noted otherwise.
- B. 90 degree motion detector shall be located at the corner of a room, facing away from sunlight, heating elements, HVAC outlets and any turbulent air movements. 360 degree motion detectors shall be located in the center of the room. The District Inspector shall confirm these on site.
- C. Provide lock-on device on all circuit breakers serving security equipment. Determine panel locations.
- D. The wiring of the system shall be executed in accordance with the drawings and the equipment manufacturer's wiring diagrams. Should any variations in these requirements occur, the contractor shall notify the architect before making any changes. It shall be the responsibility of the factory-authorized distributor of the approved equipment to install the equipment and guarantee the system to operate as per plans and specifications.
  1. Furnish all conduit, junction boxes, conductors, equipment plugs, terminal strips, etc., and labor to install a complete and operable system.
  2. The cables within racks or cabinets shall be carefully cabled and laced with no. 12 Cord waxed linen lacing twine or ty-raps. All cables shall be numbered for identification.
  3. Splices of conductors in underground pull boxes are not permitted.
  4. The labor employed by the contractor shall be regularly employed in the installation and repair of the specified systems and shall be acceptable to the owner and architect to engage in the installation and service of this system.
  5. The contractor shall thoroughly clean all equipment and materials. All exposed parts of the equipment, cabinets, and other equipment shall be left in a clean condition, unblemished and free of all dirt, dust, smudges, spots, fingerprints, etc., The contractor shall remove all debris and rubbish occasioned by the electronic systems work from the site. The contractor shall thoroughly clean all buildings of any dirt, debris, rubbish, marks, etc., Caused by the performance of this work.
  6. The system must meet all local and other prevailing codes.
  7. All cabling installations shall be performed by qualified technicians.
  8. All cabling shall be splice free.
  9. In order to ensure proper terminations, it is required that all cables shall be stripped using a special tool approved by the manufacturer of the cable / terminating device.

10. The use of lubricants (i.e. Yellow 77) to facilitate the installation of cables in conduits is highly discouraged. If such a lubricant must be used, the contractor shall verify the acceptability of the lubricant to be used with the cable manufacturer, prior to using such a lubricant.
11. Under no circumstance are "channel locks" or other pliers to be used.
12. All cabling shall be in conduit.
13. All firewalls penetrated by system cabling shall be sealed by use a non-permanent fire blanket or other method in compliance with the current edition of National Fire Protection Association (NFPA) and the California Electric Code (CEC) or other prevailing code. The contractor must not use concrete or other non-removable substance for fire stopping on cable trays, wireways or conduits. Contractors who use this method will be required to replace all cables affected and provide the original specified access to each effected area.
14. Materials shall be installed in strict compliance with local building codes. All work shall be performed in accordance with the Digital Monitoring Products, Inc. instructions and in a manner satisfactory to the Owner's representative.
15. The installer shall be fully qualified and factory trained by Digital Monitoring Products, Inc. in the installation, operation, and programming of the system.
16. System shall be, with out exception, be installed in a individual exact point identification fashion. This means that each and every point to be annouciated and reported as to it's exact device.

### **3.02 GENERAL TESTING REQUIREMENTS**

- A. Provide all instruments for testing and demonstrating in the presence of the owner's inspector that the frequency response is as stated in the factory data sheets. Check all circuits and wiring to verify they are free of shorts and grounds.
- B. System shall detect the entry through the motion of a body taking not more than four steps in an area secured with motion detection equipment where entry doors or windows are possible access. System shall be complete and properly operating prior to calling for the test. The inspector, contractor and engineer shall walk test system at district's option and contractor shall make minor satisfactory adjustments to the system in the presence of the inspector. Contractor shall coordinate the time of test with the district inspector. This test shall be performed during a time when there are no other persons on the site.
- C. Provide two portable radio transceivers to be used when walk testing the system. The transceivers shall be capable of communication throughout the entire site.

### **3.03 FINAL ACCEPTANCE**

- A. The Owner or Owner's representative may visit the site during the installation of the system to ensure that correct installation practices are being followed.
- B. The Owner or Owner's representative will conduct a final job review once the contractor has finished the job. This review will take place within one week after the contractor notifies the owner.
- C. Two copies of all certification data and drawings for all identifications shall be provided to the Owner before the owner's review.
- D. The Owner or Owner's representative will review the installation and certification data prior to the system acceptance.
- E. The Owner or Owner's representative may test some of the systems features to ensure that the certification data is correct. If a substantial discrepancy is found, the Owner reserves the right to have an independent consultant perform a certification of the entire system. If such a procedure is undertaken, the cost of the testing will be billed back to the contractor.
- F. In the event that repairs or adjustments are necessary, the contractor shall make these repairs at his own expense. All repairs shall be completed within 10 days from the time they are discovered.

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- G. The contractor shall provide not less than eight (8) hours for site instruction of personnel in the operation and maintenance of the installed systems. This instruction time shall be divided as directed by the Owner.
- H. Provide as part of the closeout paperwork 5 copies 8 ½ x 11 bound booklet containing reduced floor plans indicating diagrammatically and their connections, pathways, identification addresses on the system, etc. Provide diagrams for the overall system, and plans of each building or area. Provide keys and legends as needed to clearly describe the entire system.

**END OF SECTION**



**SECTION 28 3100 - FIRE DETECTION AND ALARM**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Design, furnish, install, test, certify, and place into service a complete addressable fire alarm system. The system shall be complete with all hardware and software specifically tailored for this installation.
- B. Provide a fire alarm system consisting of, but not limited to the following components:
  - 1. Fire alarm control panel (FACP)
  - 2. Conduit and wiring necessary to connect the FACP to alarm initiating devices, notification appliances and auxiliary equipment
  - 3. Addressable manual fire alarm stations
  - 4. Addressable analog area smoke detectors
  - 5. Addressable analog heat detectors
  - 6. Connections to sprinkler waterflow alarm switches
  - 7. Connections to sprinkler supervisory switches and tamper switches
  - 8. Audible and visual combination notification appliances
  - 9. Air handling systems shutdown relays
  - 10. Elevator recall/shunt relays (if the building has an elevator)
  - 11. Battery standby
  - 12. Conduit and GFE cable to building's main telecommunications room
- C. Provide a fire alarm system that conforms to the requirements of the latest editions of (1) NFPA 72 National Fire Alarm and Signaling Code, (2) NFPA 70 National Electrical Code, (3) ASME A17.1 Safety Code for Elevators and Escalators, and (4) NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.

**1.02 SYSTEM FUNCTIONAL DESCRIPTION**

- A The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors
- B The fire alarm system shall be manufactured by an ISO 9001:2008 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- C The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof). It's acceptable for peripheral devices to be manufactured outside of the U.S. by a division of the U.S. based parent company.
- D The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.
- E The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.
- F The system shall identify any off normal condition and log each condition into the system database as an event.
- G The system shall automatically display on the control panel the first event of the highest priority by type. The priorities and types shall include alarm, supervisory, and trouble.

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- H The system shall have a queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color-coded indicator for each type of event.
- I The user shall be able to review each event by selecting scrolling keys.
- J New alarm, supervisory, or trouble events shall sound a silence-able audible signal at the control panel.
- K Operation of any alarm-initiating device shall automatically:
  - 1. Update the control/display as described above.
  - 2. Audibly and visibly annunciate the alarm condition at the FACP.
  - 3. Activate all NAC appliances in accordance with the respective evacuation plan and matching functional matrix. The fire alarm evacuation tone shall be the three-pulse temporal pattern.
  - 4. Operate the alarm relay and initiate the transmission of an alarm signal to the LANL central station over a digital alarm communicator system.
- L Activation of a supervisory initiating device shall:
  - 1. Update the control/display as described above.
  - 2. Audibly and visibly annunciate the supervisory condition at the FACP.
  - 3. Operate the supervisory relay and initiate the transmission of a supervisory signal to the LANL Central Station over a digital alarm communicator system.
- M The entire fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the FACP. Any opens, grounds, or disarrangement of system wiring and shorts across alarm horn/strobe wiring shall automatically:
  - 1. Update the control/display as described above.
  - 2. Operate the trouble relay contacts to initiate the transmission of a trouble signal to the LANL central station over a digital alarm communicator system.
  - 3. Visually and audibly annunciate a general trouble condition, on the FACP. The visual indication shall remain on until the trouble condition is repaired.
- N The FACP shall have an optional LED Annunciator/Switch Card component installed and programmed for pre-defined disable groups particular to this installation. Disable groups shall consist of the following to facilitate routine inspection, testing, and maintenance (ITM):
  - 1. All control relays that initiate/control closure of the specified combination fire/smoke dampers listed in Sections 1.2.B.6 and 1.2.B.7.
  - 2. All notification appliances.
  - 3. Complete maintenance and repair service for the fire detection system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
  - 4. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, required tests, and list pricing for any replacement products included on the bill of materials, along with the list pricing for products not on the bill of materials; if test and inspection rates are different than full service rates the bid/proposal shall include pricing for all levels for a minimum period of five (5) years. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

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5. Include, also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the warranty.

### 1.03 SYSTEM DESIGN

- A. System Design: Provide the services of a qualified factory trained fire alarm designer for the FACP to be installed on this project. The designer shall assure the completeness and correctness of the fire alarm system design by performing the following:
  1. Prepare drawings of FACP indicating location of components, interconnection of components and connections to alarm initiating, indicating, and auxiliary circuits.
  2. Prepare a system input/output matrix to verify that the proper sequences occur for each initiating point or zone.
  3. Prepare drawings of fire alarm layout, conduit and wiring plans. Show location of all fire alarm appliances, conduit layout, quantity, and type of wires in each conduit, and interface with other systems for functions such as central station signaling, fan shutdown, damper operation, and elevator recall.
  4. Prepare terminal-to-terminal field wiring diagrams for alarm initiating, indicating and auxiliary circuits; detail the interfaces with other systems; indicate labeling of each fire alarm system conductor.
  5. Calculate conductor sizes for each alarm initiating, indicating, and auxiliary circuit; limit voltage drops so that they do not exceed the FACP manufacturer's limitations, for the most remote device on each circuit.
  6. Prepare battery load calculations for the FACP and any remote power supply panels and select proper battery size. Battery shall be sized to include an additional 50% safety margin above calculated system demand.
  7. Calculate alarm signal in all spaces to comply with ADAAG requirements: minimum 15 dBA above ambient at all locations, but not over 120 dBA at any location.
  8. Select alarm initiating, alarm indicating, and auxiliary devices compatible with FACP.

### 1.04 ACTION SUBMITTALS

- A Provide the following per project submittal procedures.
  1. Certifications
    2. Within 30 days after Notice to Proceed (submittal; see Appendix), certifications of the qualifications of the fire alarm installing firm as described in the quality assurance paragraph of this Section.
    3. Within 30 days after Notice to Proceed (~60% submittal; see Appendix), certifications of the qualifications of the fire alarm system technician as described in the quality assurance paragraph of this Section.
    4. Certification from the fire alarm control manufacturer that proposed alarm-initiating devices, alarm appliances, and auxiliary devices are compatible with the FACP and other auxiliary equipment.
  5. Delegated Design Submittals
  6. Calculations: Submit the following with Design Drawings

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- a. System battery capacity calculations to demonstrate that the battery is sized to support the system operating in a "normal" (non-alarm) condition for not less than 24 hours plus a general alarm condition (all alarm notification appliances used for evacuation being activated) for not less than 10 minutes following the completion of the 24-hour period. Battery shall be sized to include an additional 20% safety margin above calculated system demand.
  - b. Voltage drop calculations to demonstrate that the signal voltage at the most remote notification appliances on each circuit will not be less than the FACP or the notification appliance manufacturer's recommendations.
7. Design/Installation Drawings
  - a. Prepare floor plan drawings using a minimum scale of 1/8" - 1'0" for plans and 1/4" = 1'-0" for details.
  - b. Hand-lettering shall be a minimum of 3/16" and other lettering a minimum of 1/8" to permit reproduction.
  - c. Show location of FACP, all fire alarm appliances, conduit layout, quantity and type of wires in each conduit, and interface with other systems for functions such as central station signaling, fan shutdown, damper operation, and elevator recall.
  - d. Show layout of the FACP indicating location of components, interconnection of components, and connections to alarm initiating, indicating, and auxiliary circuits.
  - e. Provide terminal-to-terminal wiring diagrams for alarm circuits, supervisory circuits, remote power supply panels, and interfaces with other systems such as HVAC and elevators.
  - f. Submit with calculations at least 30 days prior to scheduled start of fire alarm system installation (~60%, 90%, 100% submittals; see Appendix). Installation shall not proceed without 100% Submittal design approval by the LANL Fire Protection Group.
8. Catalog Data: For all equipment furnished under this Section. See Appendix for submittal schedule.
9. Installation Instructions: See Appendix for submittal schedule.
10. Materials and Parts List: See Appendix for submittal schedule.
11. FACP Program
  - a. Provide FACP input/output matrix and a copy of the proposed FACP program at least two weeks prior to the anticipated pre-test date of the fire alarm system.
  - b. Provide final FACP input/output matrix and the final FACP program before requesting final tie-in/acceptance testing.
12. O&M Manual
  - a. Submit operating and instruction manuals with the 100% submittal of calculation and drawings
  - b. Submit five complete sets of project-specific operating and maintenance instruction manuals upon successful completion of testing. Provide complete, step-by-step testing instructions giving recommended and required testing frequency of all equipment, methods for testing each piece of equipment, and a complete trouble shooting manual explaining how to test the primary internal parts of each piece of equipment. Maintenance instructions shall be complete, easy to read, understandable, and shall provide the following information:
    - 1) Provide instructions for replacing any components of the system, including internal parts.
    - 2) Provide a list of recommended spare parts.

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- 3) Provide instructions for periodic cleaning and adjustment of equipment with a schedule of these functions.
  - 4) Provide a complete list of all equipment and components with information as to the address and telephone number of both the manufacturer and local supplier of each item.
- c. Provide operating instructions prominently displayed on a separate sheet located next to the FACP in accordance with UL Standard 864.

### M Test Reports

- a. Submit report of the pre-final tests indicating system status and corrective actions required before requesting the final acceptance tests.
- b. Submit test plan for the final acceptance tests of unique/special fire detection and alarm equipment such as UV/IR fire detectors, high-sensitivity smoke detection (HSSD) systems, air-aspirating/sampling detectors, linear fire detectors, and others having special manufacturer's requirements and recommendations for acceptance testing, before requesting the final acceptance tests.
- c. Upon successful completion of final acceptance tests, submit final "Record of Completion" and "Inspection and Testing Form" as required by NFPA 72.

### N Project Record Documents

- a. Provide updated drawings reflecting as-built conditions showing the work completed under this Section. Include notes on special systems or devices, new and existing, locations of equipment, actual conduit installation, wiring color-coding, wire tag notations, interconnections between all equipment, and internal wiring of the equipment. Include conduit size, conductor size, and number of conductors per conduit.
- b. Provide the updated drawings on electronic media in ".pdf" and AutoCAD "\*.dwg" formats.
- c. Provide "Record of Completion" and associated documentation for the completed system according to NFPA 72.

- O Warranties: Warrant all equipment and wiring free from inherent mechanical and electrical defects for one year (365 days) from the date of final acceptance, in writing.

## 1.05 QUALITY ASSURANCE

### A Qualifications of the installing firm:

- a. Be licensed by any state in the United States to engage in the design, fabrication, and installation of fire alarm systems.
- b. Have satisfactorily installed at least twenty fire alarm systems of equivalent nature and scope to the system described in this Section.
- c. Provide the services of a qualified fire alarm system technician to design the fire alarm system and to test the completed system.
- d. Be a factory-certified representative of the manufacturer of the FACP that will be used on this project.

### B Qualifications of the fire alarm system technician:

- a. Be factory trained in the theory, operation, installation, and troubleshooting of the FACP that will be used for this project.
- b. Have satisfactorily designed at least twenty fire alarm systems of equivalent nature and scope to the system described in this Section.
- c. Have satisfactorily field-tested at least twenty fire alarm systems of equivalent nature and scope to the system described in this Section.

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- d. Be NICET (National Institute for Certification in Engineering Technologies) Fire Alarm Certified, or certified by an equivalent organization acceptable to the LANL Fire Authority Having Jurisdiction.

### 1.06 PRODUCT HANDLING

- A Materials and Equipment: Protect from damage during shipping, storage, and installation.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A Provide materials and equipment that are new and unused, free of defects, specifically designed for the use intended, conform to the requirements of the NEC and NFPA 72, and are NRTL listed for the intended use.
- B Provide products suitable for operation at an elevation of 7,500 ft.

### 2.02 FIRE ALARM CONTROL PANEL

- A Main FACP shall be a NOTIFIER Model NFS-320 and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.
- B The FACP shall incorporate all control electronics, relays, and necessary modules and components in a flush or semi-flush mounted cabinet (dependent on FACP mounting location). The operating controls and zone/supervisory indicators shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified. The assembly shall contain a base panel, system power supply and battery charger with additional modules to meet the requirements of these specifications.
- C System circuits shall be configured as follows: Addressable analog loops Class B/Style 4; Initiating Device Circuits (if used) Class B/Style B; Notification Appliance Circuits Class B/Style Y.
- D The system shall store all basic system functionality and job specific data in non-volatile memory. The system shall survive a complete power failure intact.
- E The system shall allow down loading of a job specific custom program created by system application software. It shall support programming of any input point to any output point.
- F The system shall support distributed processor intelligent detectors with the following features: integral multiple differential sensors, environmental compensation, pre-alarm, dirty detector identification, automatic day/night sensitivity adjustment, dual normal/alarm LEDs, relay bases, and isolator bases.
- G The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of "same type" devices without the need of addressing and impose the "location" parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is defined in the system.
- H The system shall have a nationally recognized testing laboratory (NRTL) listed detector sensitivity test feature, which will be a function of the smoke detectors and performed automatically.
- I All panel modules shall be supervised for placement and initiate a trouble signal if damaged or removed.
- J The system shall have a CPU monitoring circuit to initiate a trouble signal should the CPU fail.
- K The system evacuation signal rate shall be suitable to support audio-visual combination-type electronic three pulse temporal pattern sounder and strobe combination units.

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- L The system program shall meet the requirements of this project, current codes and standards, and satisfy the LANL Fire Authority Having Jurisdiction.
- M Passwords shall protect any changes to system operations.
- N The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc for notification appliance circuits. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 10 minutes.
- O The FACP shall have a high-contrast, alphanumeric display to show system status, alarm information, and supervisory information. The FACP shall have LED indicators for the following common control functions: AC power, alarm, supervisory, monitor, trouble, disable, ground fault, CPU fail, and test. There shall be control keys and visual indicators for; reset, alarm silence, trouble silence, and drill.
- P Battery boxes, if required, shall be UL Listed for the purpose.
- Q The FACP shall have a digital alarm communicator transmitter (DACT) module to transmit detailed alarm, supervisory and trouble signals to a digital alarm communicator receiver (DACR) at a Central Monitoring Station.
- R The DACT shall support dual telephone lines, "contact ID" communications format, and configured for dual-tone, multi-frequency (DTMF).
- S The DACT shall be listed for "Central Station Fire Service" and for "Proprietary Station Fire Service" and shall be of the same manufacturer as the control panel.
- T The DACT shall transmit the following information to the LANL Central Station:
  - 1. Fire alarm per point addressable device (e.g., detector or water flow activation, manual pull stations, etc.)
  - 2. Supervisory signal per addressable device (e.g., valve tamper)
  - 3. General System Trouble (alarm panel trouble)
    - a. Loss of AC Power
    - b. Communication Line Failure (Primary and Backup)
    - c. Trouble per zone or point addressable device
    - d. Battery Failure
- U Restoration of each signal condition identified above shall be transmitted to the LANL Central Station.
- V The secondary telephone line shall only be utilized for signal transmission in the event that attempts to communicate utilizing the primary line are unsuccessful.
- W The secondary telephone line shall have the same account code and communication format as the primary line.
- X A general alarm or supervisory signal shall not be transmitted by the DACT when specific point/zone information is transmitted.
- Y Loss of AC power shall be transmitted 3 hours after the detected failure.
- Z A test signal shall be sent once every 24 hours.
- AA For consistency, telephone wire color configuration shall be as follows:

### 2 - Two-pair wire

To DACT		To Premise Telephone	
Cable 1	Cable 2	Cable 1	Cable 2

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Tip 1	Ring 1	Tip 2	Ring 2	Tip House 1	Ring House 1	Tip House 2	Ring House 2
Green	Red	Green	Red	Black	Yellow	Black	Yellow

### 2.03 LED ANNUNCIATOR/SWITCH CARD

- A Provide compatible components programmed per the pre-defined disable groups in Paragraph 1.2.E particular to this installation.
- B Manufacturers: NOTIFIER Annunciator Control Module ACM-24AT.

### 2.04 ADDRESSABLE THERMAL DETECTORS

- A Provide addressable, intelligent, fixed temperature or rate-of-rise thermal detectors that are compatible with and acceptable to the FACP manufacturer. The heat detection design documentation shall state the required performance objective of the system. The designer responsible for the strategy of the structure as a whole shall establish the "type" selection criteria.
- B The detector shall be rated at 135°F and shall be spaced according to the detector manufacturer's spacing guidance and the structure's attributes. For applications requiring other than 135 °F, consult the LANL Fire Protection Group.
- C Manufacturers: NOTIFIER FST-951 or FST-951R, no substitutions.

### 2.05 ADDRESSABLE PHOTOELECTRIC DETECTORS

- A Provide addressable, analog, intelligent, photoelectric type smoke detectors that are compatible with and acceptable to the FACP manufacturer.
- B The photoelectric detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centers and be suitable for wall mount applications.
- C Manufacturers: NOTIFIER FSP-951. no substitutions.

### 2.06 DETECTOR MOUNTING BASES

- A Provide standard bases suitable for mounting on 3-1/2" or 4" octagon box and 4" square box. The base shall contain no electronics and support all detector types. Removal of the detector shall not affect communications with other detectors.
- B Manufacturers: match smoke, heat detector device (B501 white) Low profile base.

### 2.07 DUCT SMOKE DETECTOR AND HOUSING

- A Provide addressable photoelectric detectors compatible with and acceptable to the FACP manufacturer and listed for the maximum air flow velocity anticipated.
- B Provide detector wiring so that detector can be reset at FACP.

### 2.08 AUTOMATIC SPRINKLER SYSTEM

- A Refer to Section 21 1313, Wet-Pipe Sprinkler Systems, for pressure switches, flow switches and valve supervisory switches associated with the automatic sprinkler system.
- B Provide INTELLIGENT single-input or dual-input modules as required to connect pressure switches, flow switches, and valve supervisory switches to the addressable analog loop. Each input shall provide a supervised Class B input circuit.
- C Manufacturers: NOTIFIER "FlashScan Monitor Module FMM-1" or "FDM-1 FlashScan dual monitor module." NO SUBSTITUTIONS.

### 2.09 ADDRESSABLE MANUAL PULL STATIONS

- A Provide addressable double-action, non-coded manual pull stations that are acceptable to the FACP manufacturer and are compatible with the FACP.
- B The fire alarm station shall be of Lexan or metal construction with an internal toggle switch. Provide a key locked test feature. Finish the station in red with white "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on 2-1/2" deep 1-gang boxes and 1-1/2" deep 4" square boxes with 1-gang covers.

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- C Provide the appropriate back boxes and mounting plates for flush-mounting or surface mounting (depending on the building construction).
- D Manufacturers: NOTIFIER NBG-12LX. NO SUBSTITUTIONS.

### 2.10 ADDRESSABLE CONTROL RELAY MODULES

- A Provide modules acceptable to the FACP manufacturer and compatible with the FACP.
- B The control relay module shall provide one "Form C" dry relay contact rated at 2 amps at 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.
- C Manufacturers: FRM-1, NO SUBSTITUTIONS.
- D Provide additional relays with voltage and current ratings as required to perform functions such as air handling system shutdown and elevator recall.
- E Control relays should be installed in a "readily accessible location and height".

### 2.11 AUDIBLE AND VISUAL COMBINATION NAC DEVICES

- A Provide NRTL-listed 24 VDC audio-visual combination-type electronic three-pulse temporal pattern sounder and strobe combination units that are acceptable to the FACP manufacturer and are compatible with the FACP.
- B Sounder shall include three-pulse temporal pattern generating electronics, audio transducer, and screw terminals housed in a red housing. Acoustical output shall meet requirements of UL 464. The audible signal shall be the "American National Standard Audible Emergency Evacuation Signal" (three-pulse temporal pattern) in accordance with ANSI S3.41,
- C Strobe signal output and flash rate shall meet UL 1971 and ADAAG requirements. Unit shall have a xenon flash tube enclosed in a clear Lexan lens with "FIRE" in white lettering, and shall produce a synchronized strobe flash. Provide strobes with flash output levels as required to meet NFPA 72 visual signal requirements for each space.
- D Horn/strobe shall mount to a 4" x 2-1/8" deep electrical box with single device cover. Provide weatherproof wall boxes for outdoor mounting.
- E Manufacturers: Wheelock "Exceder" series, or System Sensor "P" Series. NO SUBSTITUTIONS.

### 2.12 CONDUIT

- A Install fire alarm wiring in conduit. Minimum conduit size 3/4 inch.
- B Refer to Section 26 0533, Raceway and Boxes for Electrical Systems, for conduit systems.

### 2.13 JUNCTION BOXES

- A Refer to Section 26 0533, Raceway and Boxes for Electrical Systems, for junction boxes.

### 2.14 WIRING

- A Color Code: Use the following color code for the fire alarm system wiring:
  - 1. Black - 120-Volt AC phase wire.
  - 2. White - 120-Volt AC neutral wire.
  - 3. Green - System ground wire.
  - 4. Brown - Negative connection for strobe device. (If wired separately from horns.)
  - 5. Orange - Positive connection for strobe device. (If wired separately from horns.)
  - 6. Blue - Negative connection for horn circuit or horn/strobe combination circuit.
  - 7. Yellow - Positive connection for horn circuit or horn/strobe combination circuit.
  - 8. Gray - Negative conventional alarm initiating device connection.
  - 9. Violet - Positive conventional alarm initiating device connection.

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10. Black - Negative circuit connection for duct smoke detector reset, HVAC interlock, and other auxiliary connections.
  11. Red - Positive circuit connection for duct smoke detector reset, HVAC interlock, and other auxiliary connections.
  12. Black/Red Twisted Pair - Addressable device data loop, evacuation speaker circuit.
- B Conductors: Provide alarm and supervisory signaling system conductors that meet the requirements of Article 760 in the NEC and are NRTL-listed for the type of service to which they will be subjected. Minimum conductor requirements:
1. Interior/Dry Locations: Red-jacketed NEC type FPL cable with No. 16 AWG (minimum) twisted-pair conductors for addressable devices (shielded if required by the FACP manufacturer), and listed per UL1424.
    - a. Low voltage binary signal conductors shall be type THHN, thermoplastic insulation, No. 16 AWG minimum, and solid copper conductor.
    - b. Other low voltage conductors shall be type TFN, No. 16 AWG (minimum), thermoplastic insulation, and single solid copper conductor.
  2. Exterior/Wet Locations: Red-jacketed NEC type FPL cable with No. 16 AWG (minimum) twisted-pair conductors for addressable devices (shielded if required by the FACP manufacturer), and listed for WET locations per UL1424.
    - a. Low voltage binary signal conductors shall be type THWN-2, thermoplastic insulation, No. 16 AWG (minimum), and solid copper conductor.
  3. Power conductors shall be type THHN/THWN-2, No. 12 AWG, thermoplastic insulation, and single solid copper conductor.
  4. Size conductors of the fire alarm systems as recommended by the manufacturer, based on the operating ampacity of the circuit and the permissible resistance and voltage drop characteristics that will allow proper operation of the equipment. Provide conductors selected to provide voltages within the manufacturer specification limits for the most remote fire alarm notification appliance or field device.
  5. Design each addressable analog loop so device loading will not exceed 80% of loop capacity in order to leave for space for future devices.

### 2.15 TEST EQUIPMENT

- A Provide any special test equipment manufactured by the fire alarm equipment manufacturer for maintenance, testing, or troubleshooting.

### 2.16 SURGE PROTECTION

NOTE: All surge protectors shall be installed to be readily accessible for servicing.

- A Provide a UL 1449 listed 120V surge protective device for the main FACP, each sub-FACP, and each booster power supply that has a 120V supply circuit.
1. Device shall be capable of absorbing a maximum single pulse of at least 6,500 amperes.
  2. Clamping voltage shall not exceed 330 volts line-to-neutral when tested in accordance with ANSI/IEEE C62.31 category C1/B3.
  3. Manufacturer: EDCO Model "FAS-120AC" or as recommended by the FACP manufacturer.
- B Provide a UL 497B listed surge protective device for each analog initiating device signaling circuit entering/leaving each building that is monitored by the FACP.

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1. Device shall be capable of absorbing a peak 8x20 microsecond current of 10,000 amperes at least 10 times.
  2. Clamping voltage shall not exceed 30 volts.
  3. Capacitance shall not exceed 50pf.
  4. Provide matching receptacle for plug-in surge protective devices.
  5. Manufacturer: EDCO model "PC642C-030LC" (protects 2 pairs) and "PCB1B" socket, or as recommended by the FACP manufacturer.
- C Provide a UL 497B listed surge protective device for each 24-volt initiating device circuit or control circuit entering/leaving each building that is monitored by the FACP.
1. Device shall be capable of absorbing a peak 8x20 microsecond current of not less than 10,000 amperes at least 10 times.
  2. Clamping voltage shall not exceed 30 volts.
  3. Provide matching receptacle for plug-in surge protective devices.
  4. Manufacturer: EDCO model "PC642C-030" (protects 2 circuits) and "PCB1B" socket, or as recommended by the FACP manufacturer.
- D Provide a UL 497B listed surge four-wire protective device for each FACP RS-232 circuit entering/leaving each building monitored by the FACP.
1. Device shall be capable of absorbing a peak 8x20 microsecond current of 10,000 amperes at least 10 times.
  2. Clamping voltage shall not exceed 20 volts for RS-232 applications.
  3. Provide matching receptacle for plug-in surge protective devices.
  4. Manufacturer: EDCO model "PC642C-020" with "PCB1B" socket, or as recommended by the FACP manufacturer.
- E Provide a UL 497B listed surge four-wire protective device for each FACP RS-485 circuit entering/leaving each building monitored by the FACP.
1. Device shall be capable of absorbing a peak 8x20 microsecond current of 10,000 amperes at least 10 times.
  2. Clamping voltage shall not exceed 8 volts for RS-485 applications.
  3. Line to line and line to ground capacitance shall not exceed 50pf.
  4. Provide matching receptacle for plug-in surge protective devices.
  5. Manufacturer: EDCO model "PC642C-008LC" with "PCB1B" socket, or as recommended by the FACP manufacturer.
- F Provide a UL 497B listed surge protective device for each 24-volt notification appliance circuit entering/leaving each building that is monitored by the FACP.
1. Protective device shall have a series resistance not exceeding 0.2 ohms per pair and shall be capable of carrying a continuous current of 5 amperes.
  2. Device shall be capable of absorbing a peak 8/20 microsecond current of 5000 amperes and a 2000-ampere occurrence at least 50 times.
  3. Clamping voltage shall not exceed 43 volts.
  4. Provide matching receptacle for plug-in surge protective devices.
  5. Manufacturer: EDCO model "PHC-043" (protects 2 circuits) and "PCB1B" socket, or recommended by the FACP manufacturer.
- G Provide a single-point ground bus for each enclosure containing one or more surge protective devices. Manufacturer: EDCO model "TER-BUS" or as recommended by the FACP manufacturer.

**PART 3 EXECUTION**

**3.01 FIELD CONDITIONS**

- A Prior to installation carefully inspect the installed work of other trades, whether pre-existing or part of this project and verify that such work is complete to the point where the installation of the fire alarm system may properly commence.
- B Notify the LANL Subcontract Technical Representative (STR) if conditions exist, not resulting from work of this project, that prohibit the installation from conforming to applicable codes, regulations, standards, and the original, approved design.

**3.02 INSTALLATION**

- A General:
  - 1. Install the fire alarm system in accordance with the NEC, NFPA 72, and this specification.
  - 2. Follow Section 26 0529, Hangers and Supports for Electrical Systems, for anchorage requirements.
  - 3. Verify dimensions in the field. Lay out work in the most direct and expeditious manner to avoid interference.
  - 4. Coordinate necessary shutdowns of existing systems by notifying the LANL STR a minimum of seven working days before rendering such systems inoperative. Do not render inoperative any system without the prior approval of the LANL STR. The LANL STR will initiate and submit the LANL Utility Outage Request for Fire Protection.
  - 5. Coordinate fire alarm detectors and associated equipment with existing ceiling or roof materials, lighting, ductwork, conduit, piping, suspended equipment, structural and other building components.
  - 6. Coordinate installation of fire alarm system with work of other trades. Protect fire alarm equipment with suitable coverings until completion of Project.
- B. Device Mounting Heights:
  - 1. Install manual pull stations with center 44 inches above finished floor.
  - 2. Install combination audible/visual notification appliances with the bottom 84 inches above finished floor or 6 inches below ceiling, whichever is lower. In high bay type areas the devices may be installed at a maximum of 96 inches above the floor. Any deviations from these heights require approval from the LANL AHJ.
  - 3. Comply with ADA Accessibility Guidelines (ADAAG) for device mounting heights and locations.
- C FACP Installation
  - 1. Install FACP following manufacturer's written instructions, NFPA 72, and the NEC.
  - 2. Locate the FACP in the main building lobby or entry vestibule so fire department personnel entering the building can readily access it. Coordinate location of FACP with the LANL Fire Protection Group.
  - 3. Install FACP with top of cabinet trim 66 inches above finished floor. Refer to manufacturer's recommended installation height.
  - 4. Mount FACP plumb and rigid without distortion of the box. Mount flush cabinets uniformly flush with wall surfaces.
  - 5. Install filler plates in unused spaces in FACP.
  - 6. Train conductors in cabinet gutters neatly in groups; bundle and wrap with cable ties after completion of testing.
  - 7. Tighten electrical connectors and terminals, including grounding connections, according to the manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.
- D Control relays: Install in a readily accessible location and height acceptable to the AHJ.

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### E Wiring Installation:

1. Install fire alarm system wiring in conduit raceway.
2. Do not pull wire or cable until the conduit system is complete between pull points.
3. Bundle conductors in panels and boxes into groups by service and destination.
4. Run electronic cable continuous between termination points. No splicing is permitted without prior approval from the LANL AHJ. Where splicing is approved, use terminal strips that are acceptable to the LANL Fire Protection Group. Do not use "wire nuts."
5. Do not install AC current-carrying conductors in the same raceway with the DC or digital fire alarm detection and signaling conductors.
6. Circuit each addressable analog loop so device loading shall not exceed 80% of loop capacity in order to leave for space for future devices--the loop shall have Class B operation. Where it is necessary to interface conventional devices provide intelligent modules to supervise Class B wiring.
7. Minimize the number of T-taps in fire alarm addressable data circuits and adhere to the manufacturer requirements/limitations. Make no T-taps in notification appliance circuits. T-taps shall only be made on device terminals or on terminal strips that are acceptable to the LANL Fire Protection Group, do not use "wire nuts."
8. Make allowances in conductor length at panels and other enclosures to permit forming the conductors neatly within the enclosures. Where wiring troughs are not provided with the enclosures, neatly cable and adequately support the wiring.
9. Ring out and identify power and control conductors before terminal connections are made. Check polarity and phasing and make changes as required before making terminal connections.
10. Test conductors for continuity and for freedom from shorts or unintentional grounds.

### F Junction Box and Conduit Installation: Refer to Section 26 0533, Raceway and Boxes for Electrical Systems, requirements. Provide minimum 3/4" fire alarm system conduit.

### G Install audible and visual notification appliances in the following locations to obtain an audible signal level that is at least 15 dB above ambient but does not exceed 120 dB at any location:

1. Corridors
2. Conference rooms
3. Mechanical equipment rooms
4. Computer rooms
5. Enclosed offices where dB levels are questionable
6. Common areas such as restrooms (strobes only)
7. Use a strobe-only device in the vicinity of the FACP

### H Surge Protective Device (SPD) Installation

1. Install a 120V SPD for the main FACP, each sub-FACP, and each booster power supply.
2. Install an SPD for each initiating device circuit, notification appliance circuit, data, and signaling line circuit entering/leaving each building that is monitored by the FACP.
3. SPDs shall be installed so that they are readily accessible for servicing.
4. If permitted by the FACP manufacturer, install SPDs in the FACP cabinet.
5. If the FACP manufacturer does not allow SPDs to be installed within the FACP cabinet, install one or more metal enclosures near the protected fire alarm equipment. Provide separate enclosures for 120V and signal voltage devices, or provide one enclosure with a metal partition to separate the 120V from the signal voltage devices.
6. Install a single-point ground bar in the enclosure for the SPD. Bond the ground bar to the enclosure and to the power circuit equipment-grounding conductor. Connect each SPD to

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the ground bar with a separate 12 AWG solid, green-insulated ground wire. Keep ground wires as short and straight as possible.

7. Install SPDs in accordance with manufacturer's instructions, keeping leads and ground conductors as short and straight as possible.

### I Identification

1. Follow Section 26 0553, Identification for Electrical Systems, for all system components.
2. Label each conductor at each terminal and junction point. Use wire markers specified in Section 26 0553, Identification for Electrical Systems. On wire markers indicate the type of fire alarm circuit (e.g. Pull Stations, Fan Shutdown, Alarm Strobes, etc.).
3. Mark floor in front of cabinet(s) to show the NEC required working clearances according to Section 26 0553, Identification for Electrical Systems.
4. Label fire alarm junction boxes with 2-1/4" x 1/2" (minimum size) pressure sensitive vinyl markers having "FIRE ALARM" in red letters on a white background.
5. Label all devices with address/zone information. Use self-adhesive vinyl labels with 3/4 inch (minimum) lettering easily visible without a ladder.

### 3.03 PAINTING

- A. Exposed Surfaces: Paint exposed fire alarm conduit, panels, cabinets, pullboxes, supports, and other electrical equipment as follows:
  1. Galvanized Surfaces: Paint for repairing galvanized materials shall be zinc-rich type.
  2. Refinishing: Thoroughly clean and touch up shop-primed or finish-painted surfaces damaged in handling or installation with paint supplied with the equipment or an approved matching paint.
  3. Interior Conduit: Paint new exposed interior conduit in rooms finished and/or occupied to match the existing background paint color. Paint conduit to be painted with one coat of primer. Paint conduit to match the existing background colors with two coats of paint to provide a minimum thickness of 6 mils.

### 3.04 EQUIPMENT INSTALLATION

- A. Install devices or equipment not specifically covered by these specifications in accordance with manufacturer's instructions.

### 3.05 CONNECTION TO LANL CENTRAL STATION

- A. Install 6 x 6 x 4 enclosure adjacent to the FACP with a conduit to the appropriate factory knockout.
- B. Install a 3/4 inch conduit with measuring pull tape from the 6 x 6 x 4 enclosure to the main telecommunications room.
- C. Install two GFE Category 5e telecommunications cables in the conduit and label each end of the cable as "emergency."
- D. LANL will terminate the telecommunications cable on two 8-pin RJ-31X telephone outlet jacks in a 2-port outlet that is mounted inside the 6 x 6 x 4 enclosure. LANL will label one jack as "primary," and the other as "backup."
- E. LANL will terminate the telecommunications cable pairs to two separate lines (numbers) at the telecommunications room, selecting dedicated numbers or low-usage (lobby, conference room, etc), voice-grade, loop-start DTMF numbers that provide timed-release disconnect.
- F. LANL will connect the "primary" and "secondary" number ports on the DACT to the corresponding telephone outlet jacks.

### 3.06 CLEANING

- A. Blow out junction boxes and fire alarm equipment not hermetically sealed with clear, dry, oil-free (15 psig maximum) air to remove dust and dirt prior to energizing.

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### **3.07 FIELD QUALITY CONTROL**

- A. Provide the services of a qualified factory trained and certified technician for the FACP installed on this project. The factory technician shall assure the completeness and correctness of the installation by performing the following:
  - 1. Prepare as-built documentation of FACP indicating location of components, interconnection of components, and connections to alarm initiating, indicating and auxiliary circuits.
  - 2. Field-verify and mark as-built drawings of fire alarm layout, conduit and wiring plans, and point-to-point field-wiring diagrams.
  - 3. Verify correct labeling of fire alarm system conductors.
  - 4. Verify that conductor sizes are adequate for each alarm initiating, indicating and auxiliary circuit.
  - 5. Prepare as-built battery load calculations. Battery shall be sized to include the additional 50% safety margin above calculated system demand.
  - 6. Measure and adjust audible alarm signal in all spaces to comply with ADAAG requirements: minimum 15 dBA above ambient, but not over 120 dBA at any location.
  - 7. Test all devices for proper supervision and alarm operation.
  - 8. Test all interlocks with HVAC and elevator system for proper operation in normal and by-pass modes.
  - 9. Perform pre-final acceptance inspections and tests of the fire alarm system modifications.
  - 10. Prepare final acceptance test plan when required (see Section 1.4-D).
- B. After the pre-final test, provide a report to the LANL Project Leader indicating the status of the fire alarm system and any corrective actions required before the acceptance tests.
- C. Submit a detailed test plan for the final acceptance test.
  - 1. Submit the test plan (when required, see Section 1.4-D) not less than 10 working days before the planned final acceptance date.
  - 2. Follow test methods outlined in NFPA 72.
- D. Submit FACP program at least two weeks prior to final acceptance test.
- E. Submit final drawings, calculations, and manufacturer's data at least one week prior to final acceptance test.
- F. Coordinate date of final acceptance test with installer, LANL Project Leader, LANL Fire Protection Group representative, and subtier subcontractors for HVAC, sprinklers, and elevator controls. Make corrective actions before final acceptance test date.

### **3.08 FINAL ACCEPTANCE TEST**

- A. Notify LANL STR at a minimum of 2 weeks in advance of final acceptance tests. The more advance notice will help minimize scheduling conflicts and delays. Perform final acceptance tests in the presence of authorized representatives of LANL's STR, Fire Protection Division, and Facility Operations Director (FOD).
- B. Before the final acceptance test begins, present a preliminary copy of the Record of Completion to the authorized representative of the LANL Fire Protection Group.
  - 1. Preliminary Record of Completion shall be of the form required by NFPA 72.
  - 2. Indicate on the preliminary Record of Completion that the pre-final inspections and tests have been performed and all corrective actions have been completed.
  - 3. The final acceptance test shall not proceed before the Record of Completion is presented to the authorized representative of the LANL Fire Protection Group.
- C. Perform final acceptance tests on the completed fire alarm system:
  - 1. Follow the approved test plan and comply with NFPA 72 requirements.

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2. Test FACP and the connected initiating, alarm, and auxiliary devices.
  3. Perform 24-hour discharge test on the FACP batteries.
  4. LANL Fire Protection will perform tests on connections made by other LANL groups.
  5. LANL Telecommunications Group will perform the acceptance test of the telephone lines from the modular plug connectors, to verify telephone line continuity and switch features before turning lines over to the LANL Fire Protection Group.
- D. At the final acceptance test, have marked-up shop drawings and point-to-point wiring diagrams available for review and verification. Final acceptance test will not proceed without these as-built documents. If LANL verification of the as-built documents reveals errors, re-verify the complete fire alarm raceway and wiring system in the presence of a LANL Fire Protection Group representative.
- E. Correct deficiencies discovered in the final acceptance test and re-test fire alarm system until satisfactory test results are obtained.
- F. Upon successful completion of acceptance tests, submit final "Record of Completion" and "Inspection and Testing Form" and "recommended spare parts" list per Para 1.4.A.

### 3.09 SYSTEM IDENTIFICATION PLACARD

- A. Furnish and install a permanently mounted placard in or adjacent to the fire alarm control cabinet.
- B. Provide the following information typewritten or engraved on the placard:
1. Name, address and telephone number of installing subcontractor.
  2. Reference to the standards, including date of issue to which the system conforms (e.g. NFPA 72 and NFPA 70, latest edition).
  3. Circuit number of power supply to FACP and location of the electrical panelboard.
  4. Location of fire alarm system Operating and Maintenance Instructions if they are not stored in the FACP cabinet.
  5. Location of fire alarm system as-built documents.

**END OF SECTION**



## SECTION 311000 – SITE CLEARING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A This Section includes the following:
  - 1. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
  - 2. Removing existing trees, shrubs, groundcovers, plants, and grass.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Removing above- and below-grade site improvements.
  - 6. Disconnecting, capping or sealing, removing site utilities, and abandoning site utilities in place.
  - 7. Temporary erosion and sedimentation control measures.

#### 1.02 MATERIAL OWNERSHIP

- A Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

#### 1.03 PROJECT CONDITIONS

- A Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D Do not commence site-clearing operations until temporary erosion and sedimentation control measures are in place.

### PART 2 PRODUCTS (NOT APPLICABLE)

### PART 3 EXECUTION

#### 3.01 PREPARATION

- A Protect and maintain benchmarks and survey control points from disturbance during construction.
- B Locate and clearly flag trees and vegetation to remain or to be relocated.
- C Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

#### 3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

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- A Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### 3.03 TREE PROTECTION

- A Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
- B Do not excavate within tree protection zones, unless otherwise indicated.
- C Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

### 3.04 EXISTING UTILITIES

- A Locate, identify, disconnect, and seal or cap off utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.

### 3.05 CLEARING AND GRUBBING

- A Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of **[eight inches]** and compact each layer to a density equal to adjacent original ground.

### 3.06 TOPSOIL STRIPPING

- A Remove sod and grass before stripping topsoil.
- B Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

### 3.07 SITE IMPROVEMENTS

- A Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

### 3.08 DISPOSAL

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- A Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

**END OF SECTION**

**SITE CLEARING - 311000**

## SECTION 312000 - EARTH MOVING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A This Section includes the following:
1. Preparing subgrades for slabs-on-grade, walks, pavements, and exterior plants.
  2. Excavating and backfilling for buildings and structures.
  3. Drainage course for slabs-on-grade.
  4. Base course for concrete walks.
  5. Base course for asphalt paving.
  6. Excavating and backfilling for utility trenches.

#### 1.02 QUALITY ASSURANCE

- A Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC), latest edition and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

#### 1.03 REFERENCES

- A This specification section has been prepared using the project soils report "Proposed Addition and Renovation of Existing Library", by Geocon West Inc., October 20,2023 as a reference.

#### 1.04 DEFINITIONS

- A Backfill: Soil material used to fill an excavation.
1. Type "B" Material: Backfill placed beside pipe in a trench, including haunches to support sides of pipe.
  2. Initial Backfill: Backfill placed over pipe in a trench.
  3. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B Base Course: Course placed between the subgrade and hot-mix asphalt or concrete paving.
- C Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E Classified Excavation: Removal and disposal of materials not defined as rock
- F Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- G Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
  2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- H Fill: Soil materials used to raise existing grades.

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- I Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.
- K Unclassified Excavation: Removal and disposal of materials encountered regardless of nature of materials, including rock.
- L Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

### 1.05 PROJECT CONDITIONS

- A Examine site, Drawings, records of existing utilities and construction, record of test borings, and subsurface exploration report available from Owner. Records of test borings are for information only and are not guaranteed to represent all conditions that will be encountered.

### 1.06 PROTECTION

- A Soils Consultant: A geotechnical consultant shall advise on Construction techniques involved in work, including design, checking and approving of temporary bracing, sheeting, shoring, underpinning and other items pertinent to work, and encountered during prosecution of work. Consultant shall be primarily concerned with construction methods, which will prevent settlement or damage to surrounding structures, sidewalks, embankments, utilities and roads on Owner's property and adjoining properties.
- B Existing Utilities:
  - 1. Maintain existing utilities that are to remain in service. Before excavating over or adjacent to existing utilities, notify utility Owner to ensure protective work will be coordinated and performed in accordance with utility Owner's requirements. If existing service lines, utilities and utility structures, which are to remain in service, are uncovered or encountered during these operations, safeguard and protect from damage.
  - 2. Within limits of excavation, remove existing piping, subsoil drainage systems, conduit, manholes and relocated items, which are to be abandoned. Plug open ends of utilities to remain with concrete.
  - 3. Re-route existing subsoil drains which obstruct work around new constructions or incorporate them into new drainage systems.
  - 4. Consult Architect immediately for directions, should uncharted or incorrectly charted piping or other utilities be encountered during excavation. Cooperate with Owner and public and private utility companies in keeping their respective services, utilities and facilities in operation. If damaged, repair utilities to satisfaction of Architect and utility Owner.
- C Existing Facilities: Protect and maintain in satisfactory manner, existing pavements, curbs, gutters, structures, conduits, fences, walls and other facilities to remain above and below grade. Restore facilities damaged by construction operations.

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- D Pumping and Draining: Excavate areas in such manner as to afford adequate drainage. Control grading in vicinity of excavated areas so ground surface will slope to prevent water running into excavated areas. Until work is completed, remove water from areas of construction that may interfere with proper performance of work or that may result in damage to the soil sub-grade and provide sumps, pumps, well points, electric power and attendance required for this purpose on a 24-hour basis if necessary. Protect construction from water during construction, including prevention of erosion of completed work during construction and until permanent drainage and erosion controls are operational. Repair adjoining properties, facilities and streets damaged due to improper protection.

## PART 2 PRODUCTS

### 2.01 SOIL MATERIALS

- A General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B Satisfactory Soils: Sand, gravel, friable earth, or non-expansive clays, subject to Testing Laboratory's approval. Fill and backfill material shall be free of organic material, slag, cinders, expansive soils, trash or rubble and stones having maximum dimension greater than six inches.
- C Unsatisfactory Soils: Expansive and other soils as defined in the project's geotechnical investigation report.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within two percent of optimum moisture content at time of compaction.
- D Base Course: Material conforming to SSPWC section 200-2.2, Crushed Aggregate Base or SSPWC section 200-2.4 Crushed Miscellaneous Base.
- E Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a one and one-half-inch sieve and not more than 12 percent passing a No. 200 sieve.
- F Bedding Course:
  - 1. Flexible pipes: clean coarse sand.
  - 2. All other pipes: crushed rock conforming to subsection 200-1.2 and Table 200-1.2.1 (A) of the "Standard Specifications for Public Works Construction." For pipes up to and including 15 inches, maximum rock gradation shall be one-half inch. For pipes over 15 inches, maximum rock gradation shall be three-fourths inch.
- G Drainage Course: Narrowly graded mixture of washed, crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a one and one-half-inch sieve and zero to five percent passing a No. 8 sieve.

### 2.02 ACCESSORIES

- A Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, six inches wide and four mils thick, continuously inscribed with a description of the utility. Color coding shall be according to the American Public Works Association (APWA) standards:
  - 1. Blue – Potable water and fire suppression lines.
  - 2. Green – Sanitary sewer and storm drain lines
  - 3. Orange – Communication, alarm or signal lines
  - 4. Purple – Reclaimed water, irrigation, and slurry lines

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- 5. Red – Electrical power lines, cables, conduit and lighting lines
- 6. Yellow – Gas, oil, steam, petroleum, or gaseous material lines.

### **PART 3 EXECUTION**

#### **3.01 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 Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing" or "Demolition."
- C Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing" or "Demolition," during earthwork operations.

#### **3.02 EXCAVATION**

- A Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

#### **3.03 EXCAVATION FOR STRUCTURES**

- A Excavate to indicated elevations and dimensions within a tolerance of plus or minus one inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. 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.

#### **3.04 EXCAVATION FOR WALKS AND PAVEMENTS**

- A Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

#### **3.05 EXCAVATION FOR UTILITY TRENCHES**

- A Excavate trenches to indicated gradients, lines, depths, and elevations.
- B Excavate trenches to uniform widths to provide six-inch clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
- C Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. Excavate trenches six inches deeper than elevation required in rock or other unyielding bearing material, four inches deeper elsewhere, to allow for bedding course.

#### **3.06 SUBGRADE INSPECTION**

- A Proof-roll subgrade [**below the building slabs and pavements**] with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

**3.07 UNAUTHORIZED EXCAVATION**

- A Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 pounds per square inch (psi), may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

**3.08 STORAGE OF SOIL MATERIALS**

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

**3.09 UTILITY TRENCH BACKFILL**

- A Place backfill on subgrades free of mud, frost, snow, or ice.
- B Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C Place and compact initial backfill of clean sands, free of particles larger than one and a half inches in any dimension, to a height of 12 inches over the utility pipe or conduit.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
  - 2. The bedding material must be inspected and approved in writing by the Geotechnical Engineer.
- D Place and compact final backfill of satisfactory soil to final subgrade elevation.
- E Install warning tape directly above utilities, minimum six inches above top of pipe, minimum 12 inches below finished grade, except six inches below subgrade under pavements and slabs.

**3.10 SOIL FILL**

- A Plow, scarify, bench, or break up sloped surfaces steeper than one vertical to four horizontal so fill material will bond with existing material.
- B Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use engineered fill.
  - 3. Under steps and ramps, use engineered fill.
  - 4. Under building slabs, use engineered fill.
  - 5. Under footings and foundations, use engineered fill.

**3.11 SOIL MOISTURE CONTROL**

- A Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within two percent of optimum moisture content.



1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by two percent and is too wet to compact to specified dry unit weight.

**3.12 COMPACTION OF SOIL BACKFILLS AND FILLS**

- A Place backfill and fill soil materials in layers not more than **eight inches** in loose depth for material compacted by heavy compaction equipment, and not more than four inches in loose depth for material compacted by hand-operated tampers.
- B Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
  1. Under structures, building slabs, steps, and pavements, scarify and recompact top **12 inches** of existing subgrade and each layer of backfill or fill soil material to **95** percent.
  2. Under walkways, moisten to near optimum moisture content and recompact top **12 inches** below subgrade and compact each layer of backfill or fill soil material to **95** percent.
  3. Under lawn or unpaved areas, scarify and recompact top **six inches** below subgrade and compact each layer of backfill or fill soil material to **85** percent.
  4. For utility trenches, compact each layer of initial and final backfill soil material to **85** percent.

**3.13 GRADING**

- A General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  1. Lawn or Unpaved Areas: Plus or minus one inch.
  2. Walks: Plus or minus one inch.
  3. Pavements: Plus or minus one-half inch.
- C Grading inside Building Lines: Finish subgrade to a tolerance of one-half inch when tested with a 10-foot straightedge.

**3.14 BASE COURSES**

- A Place base course on subgrades free of mud, frost, snow, or ice.
- B On prepared subgrade, place base course under pavements and walks as follows:
  1. Shape base course to required crown elevations and cross-slope grades.
  2. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than **95** percent of maximum dry unit weight according to ASTM D 1557.

**3.15 DRAINAGE COURSE**

- A Place drainage course on subgrades free of mud, frost, snow, or ice.
- B On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds **six inches** in compacted thickness in layers of equal thickness, with no compacted layer more than **six inches** thick or less than **three inches** thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than **95** percent of maximum dry unit weight according to ASTM D 698.

**3.16 FIELD QUALITY CONTROL**

- A Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
- E When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

**3.17 PROTECTION**

- A Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

**3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

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

**END OF SECTION**

## **SECTION 32 0190 – OPERATION AND MAINTENANCE OF PLANTING**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Section Includes: Continuous maintenance of irrigation and plant material during and after maintenance period.
- B. Related Sections:
  - 1. Section 328400 - Planting Irrigation.
  - 2. Section 329000 - Planting.

#### **1.02 ADMINISTRATIVE REQUIREMENTS**

- A. Maintenance Period: After landscape planting and irrigation work have been completed, reviewed, and accepted by Owner and Landscape Architect, continuously maintain planted areas by means of watering, weeding, rolling, pruning, mowing, reseeding, cultivating, spraying, mulching, trimming, edging, and other operations necessary for care and upkeep for a period of 90 calendar days minimum, but not before final acceptance of Project by Owner.
  - 1. Preliminary Review: As soon as the landscape installation is complete, coordinate a preliminary review with the Landscape Architect to determine the condition of the work and acceptance to begin the maintenance period.
  - 2. Date of Review: Submit a written request to the Landscape Architect at least 5 working days prior to anticipated date of review.
  - 3. Beginning of the Maintenance Period: The date on which the Landscape Architect issues a letter of Preliminary Acceptance to the Owner based on the Landscape Architect recommendation of acceptance.
- B. Scheduling:
  - 1. Perform maintenance during hours mutually agreed upon with Owner.
  - 2. Schedule work with sufficient personnel at intervals as often as necessary to perform specified establishment of planting materials as required to comply with maintenance requirements.
- C. Observations: Normal progress observations shall be requested by the Contractor from the Landscape Architect in accordance with observations identified in Section 0329000.

#### **1.03 SUBMITTALS**

- A. Closeout Submittals: Furnish one set of 30" by 42" as well as digital files, CD or thumb drive, blackline prints labeled AS BUILTS to the Owner, after review by the Landscape Architect, and one month prior to the end of the maintenance period.
- B. Furnish monthly record of herbicides, insecticides, and disease control measures to County Agricultural Commissioner's Office.

#### **1.04 QUALITY ASSURANCE**

- A. Qualifications: Demonstrate experience in horticulture and landscape maintenance, practices, and techniques. Provide sufficient number of workers with adequate equipment to perform the work during the maintenance period.
  - 1. Employ a full time Foreman to the Project for the duration of the Maintenance Period. Foreman shall have a minimum of 4 years experience in landscape establishment supervision, with

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experience or training in entomology, pathology, pest control, soil science, fertilizers, plant materials and horticultural practices in the region in which the Project occurs.

2. Supervision: Foreman shall directly supervise the labor force at all times. Notify the Owner when changes in supervision occur.

### 1.05 WARRANTY

- A. Warranty Period: Refer to Sections where plant and irrigation materials are specified.
- B. Plant material and other materials installed under the Contract shall be guaranteed against inadequate and inferior materials and workmanship or improper maintenance as determined by the Landscape Architect, and shall be replaced by the Contractor at no cost to the Owner. Warranty periods are as follows:
  1. Trees, vines, and shrubs: One Year
  2. Groundcover and Turf: One year.
- C. Replacement: Materials found to be dead, missing, declining, or not in an unsatisfactory or unhealthy condition during the maintenance period shall be replaced immediately. Landscape Architect shall be sole judge as to the condition of material. Material shall be replaced within the warranty period by the Contractor within five days of written notification by the Landscape Architect or Owner. Replacement materials and installations shall comply with the Contract Drawings.
  1. Plants missing due to suspected theft shall be replaced by the Contractor. If the Contractor suspects that theft may be a problem, the Contractor shall notify the Owner in writing that security on this site needs to be intensified.
- D. Contractor may be released of theft responsibility if, after the notice, the Owner has failed to improve security, and the Contractor gives written notice that plant material will not be replaced for theft or vandalism due to lack of site security adequate.
  1. This procedure may take place only during the landscape maintenance period.

## PART 2 - PRODUCTS

### 2.01 REGULATORY REQUIREMENTS

- A. Regulations: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

### 2.02 MATERIALS

- A. Provide materials used in conjunction with the maintenance work in accordance with the requirements of Section 328400 and Section 329000.
  1. Fertilizers: Balanced, once a season application fertilizers with a blend of coated prills which supply controlled-release nitrogen phosphorus, and potassium, including uncoated, rapidly soluble prills containing nitrogen and phosphorus.
    - a. Furnish a monthly record of herbicides, insecticides, and disease control chemicals used and irrigation scheduled.
    - b. *Amendments listed herein are for Bidding purposes only. The final amendment types and rates shall be determined by the Agronomic Soils Test.*
  2. Water: Clean, potable, fresh, on site water furnished and paid for by Owner.

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- B. Turf Maintenance Fertilizer: Best Turf Supreme 16-6-8 consisting of the following percents by weight:
  - 1. 16% nitrogen
  - 2. 6% phosphoric acid
  - 3. 8% potash
- C. Slow Release Maintenance Fertilizer: Best Superturf 25-5-5 with Polyon consisting of the following percents by weight:
  - 1. 25% nitrogen
  - 2. 5% phosphoric acid
  - 3. 5% potash
- D. Top Dress Fertilizer: Soillogix Master Growth, distributed by Target Specialty Products (562)225-3420, or equal.
  - 1. Dosage: 10 pounds per 1000 square feet.
- E. Insecticides: Best quality, non-staining materials with original manufacturer's containers, properly labeled with guaranteed analysis.
- F. Fungicides: Subdue Maxx and Cleary's 3336, distributed by Target Specialty Products (562)225-3420, or equal.

### PART 3 - EXECUTION

#### 3.01 MAINTENANCE PERIOD

- A. Preliminary Review: As soon as the landscape installation is complete, coordinate a preliminary review with the Owner and Landscape Architect to determine the condition of the work and acceptance to begin the maintenance period.
- B. Date of Review: Submit a written request to the Landscape Architect at least 5 working days prior to anticipated date of review.
- C. Beginning of the Maintenance Period: The date on which the Landscape Architect issues a letter of Preliminary Acceptance to the Owner based on the Landscape Architect recommendation of acceptance.

#### 3.02 FERTILIZING

- A. Fertilizers and soil conditioners are preliminary and are specified for bid purposes only. Specific recommendations will be made after final soils analysis tests are complete.
- B. Apply an application of Gro-Power 16-6-8, or equal, commercial fertilizer at the rate of 8 pounds per 1,000 square feet 30 days after planting.
  - 1. Repeat fertilizer application at 45- to 60-day intervals until the end of the maintenance period.

#### 3.03 GENERAL MAINTENANCE

- A. General: Proper maintenance, including watering, weeding, mowing, edging, fertilization, rolling of turf, replacement and infill of mulch replacement of jute mesh, infill of settled areas, repairing and protection shall be required until entire project is finally accepted, but in any event for a period of not less than the specified maintenance period after planting.
- B. Watering: Thoroughly water to insure vigorous and healthy growth until work is accepted. Water in a manner to prevent erosion due to application of excessive quantities of water. When hand

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watering use a water wand to break the water force. Supplemental hand water as required to maintain and encourage the proper growth of new and existing plant material.

### C. Weeding:

1. Keep plant basins, turf areas and areas between plants free of weeds. Control weeds with pre-emergent herbicides. If weeds develop, use legally approved herbicides and hand remove. Avoid frequent soil cultivation that destroys shallow roots. Weeding also shall be included in paved areas including public or private sidewalks.
2. Hand weed as required in addition to the application of weed control herbicides and pre-emergent to maintain areas free of weeds including turf species other than the specified species. Periodic or predetermined weeding schedules may not be adequate and should be supplemented.
3. Apply a final application of pre-emergent herbicide at the end of the maintenance period, one week prior to final acceptance.

### D. Tree basins in turf areas: Remove turf from around each tree to create a 2'-0" to 3'- 0" diameter basin according to variance in tree size.

### E. Pruning

1. Trees: Prune trees to select and develop permanent scaffold branches; to eliminate narrow V-shaped branch forks that lack strength; to reduce toppling and wind damage by thinning out crowns; to maintain a natural appearance and to balance crown with roots. Trees shall be maintained and pruned in accordance with the accepted practices of the International Society of Arboriculture (ISA). Prune only as directed by the Landscape Architect.
2. Shrubs: Same objectives as for trees. Shrubs shall not be clipped into balled or boxed forms unless such is required by the landscape plans. Pruning cuts shall be made to lateral branches, buds or flush with the trunk. Stubbing and heading shall not be permitted unless directed by Landscape Architect.
3. Only skilled workers shall perform pruning work in accordance with standard horticultural pruning practices. Remove from the project pruned branches and material. Remove and replace any plant material excessively pruned or malformed resulting from improper pruning practices at no additional costs to the Owner.
4. Improperly pruned plant material as determined by the Landscape Architect is to be replaced by Contractor at no cost to the Owner.

### F. Staking and Guys: Stakes and guys shall remain in place through the guarantee period and shall be inspected and adjusted to prevent rubbing that causes bark wounds. Remove nursery stake from trees that are staked with lodgepole stakes per specifications. Provide supplemental staking or guying as required during high wind events to prevent damage to trees. Any damaged tree caused by high winds must be replaced by the contractor at no cost to the Owner.

### G. Insect, Animal, Rodent and Disease Control: Maintain proper control with legally approved materials as required as part of the Contract.

### H. Protection: The Contractor shall maintain protection of the planted areas. Damaged areas shall be repaired or replaced at the Contractor's expense.

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- I. Trash: Remove trash weekly in planted areas, pedestrian walkways and parking areas. Maintain areas free of trash, clippings, and debris at all times.
- J. Replacement: As per Guaranty and Replacement Specifications of this Section.
- K. Fertilization: Fertilize planting areas, during and just prior to end of maintenance period with the slow release maintenance fertilizer as indicated in the agronomic soils report.
- L. Watering: Lawns shall be watered at such frequency as weather conditions require to replenish soil moisture below root zone and to establish healthy strands of grass.
  - 1. Contractor is responsible for water audits and payment of local penalties by local water districts at no additional cost to the Owner.

### 3.04 LANDSCAPE PLANTING MAINTENANCE

- A. Provide maintenance of new planting consisting of watering, cultivating, applying pre-emergence weed control, weeding, mulching, restaking, pruning, tightening and repairing of guys, resetting plants to proper grades or upright position, restoration of planting saucers, and furnishing and applying such sprays and invigorants as are necessary to maintain the plants free of insects and disease and in thriving condition.
- B. Irrigate planting areas as required to ensure active growth. Maintain planting areas in a moist, but not saturated, condition. Regulate irrigation as necessary to avoid erosion and gullyng and as to not surpass Water District consumption allocations.
  - 1. Supplemental hand watering may be required to maintain new and existing planting.
  - 2. When hand watering, use water wand to break the water force.
- C. Inspect plants, including turf, for disease or insect damage weekly. Treat affected material immediately.
  - 1. Remove damaged or diseased growth from trees and shrubs. Treat cuts larger than 1/2-inch in diameter with tree paint.
  - 2. Immediately remove any dead or dying plants not in a vigorous thriving condition. Replacement plants shall be the same species and size as those originally planted.
  - 3. Pruning: Pruning work shall be performed by skilled workman in accordance with standard horticultural pruning practices. Remove from the project pruned branches and other excess material. Remove and replace plant material excessively pruned, or malformed plants resulting from improper pruning practices at no additional cost to Owner.
    - a. Trees: Prune trees to select and develop permanent scaffold branches; to eliminate narrow V-shaped branch forks that lack strength; to reduce toppling and wind damage by thinning out crowns; to maintain a natural appearance and to balance crown with roots. Prune only as directed by the Landscape Architect.
    - b. Shrubs: Maintain a natural appearance. Shrubs shall not be clipped into balled or box forms unless required by the Contract Landscape Drawings. Pruning cuts shall be made to lateral branches, buds, or flush with the trunk. "Stubbing" and "heading" shall not be permitted.
- D. Restake, tighten, and repair guys. Reset to proper grades or upright position any plants that are not in their proper growing position. Stakes or guys shall remain in place through the guaranty period. Readjust tree ties to prevent rubbing.
- E. Mow turf to a height of 1-1/2 inches minimum and trim edges whenever the average height exceeds 2 inches. Remove clippings and dispose in a legal manner.

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- F. Weeding: Keep plant basins and areas between plants free of weeds. Control weeds with pre-emergent herbicides. If weeds develop, use legally approved herbicides. Avoid frequent soil cultivation that may destroy shallow roots. Weed paved areas including public or private sidewalks.
- G. Insect, Animal, Rodent, and Disease Control: Control with legally approved materials as required.
- H. Protection: Maintain protection of the planted areas. Damaged areas shall be repaired or replaced at the Contractor's expense.
- I. Trash: Remove trash weekly in newly planted areas, pedestrian walkways, patios, and plazas.
- J. If it becomes evident that certain turf areas and groundcovers have not established uniformly or properly, replant the areas immediately with the same plants and quantity as specified to achieve 90 percent coverage of healthy, actively growing turf and groundcovers for acceptance at Final Review.

### 3.05 LAWN AND TURF MAINTENANCE

- A. Mowing and Edging
  - 1. Initial mowing of turf will commence when the grass has reached a height of 2-1/2 inches. The height of cut will be 2 inches. After initial establishment maintain Bermuda and creeping grasses at 1-1/2" and fescues or rye grass at 2". Mowing will be at least every 4-6 days for the second through fifth cuttings, and at least once per week after that for fescue. Bermuda grass is to be mowed minimum twice a week. Bent grass is to be mowed daily. Turf must be well established and free of bare spots and weeds to the satisfaction of the Landscape Architect prior to final acceptance.
  - 2. Excess grass clippings shall be picked up and removed from the site and premises. Let turf areas dry out enough so that mower wheels do not skid, tear or mark the lawn. Edges shall be trimmed at 90 degrees to pavement, at least weekly or as needed for neat appearance. Clippings shall be removed from paved and planting areas, etc. and disposed of from the site.
- B. Watering: Lawns shall be watered at such frequency as weather conditions require to replenish soil moisture below root zone and to establish healthy strands of grass.
  - 1. Contractor is responsible for water audits and payment of any local penalties by local water districts at no additional cost to the Owner.
- C. Disease control: Control turf diseases throughout the maintenance period with legally approved fungicides and herbicides. Replace any damaged or infected grass.
- D. Weed Control:
  - 1. Control broad leaf weeds with selective, legally approved herbicides throughout maintenance period.
  - 2. A final application of selective herbicide shall be applied at the end of the landscape maintenance period, acceptance, just prior to final acceptance.
  - 3. Hand weed as required in addition to the application of weed control herbicides and pre-emergent to maintain areas free of weeds including turf species other than the specified species. Periodic or predetermined weeding schedules may not be adequate and should be supplemented.
- E. Fertilization:
  - 1. During maintenance period an application of turf maintenance fertilizer, as specified, shall be made at thirty (30) day intervals from the date of maintenance period start at a rate of five (5) pounds per 1,000 square feet, and as required by the agronomic soils report.

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2. Final application (just prior to final acceptance) shall be made with the slow-release maintenance fertilizer as required by the agronomic soils report.
  3. Replacement: At conclusion of maintenance period a final observation of lawn and turf areas shall be made. Remove diseased areas and unhealthy strands of grass from the site; do not bury into the soil. Replant areas with material and in a manner as specified on the Contract Drawings at no additional cost to the Owner. Grass shall be fully grown with 100% coverage with a suitable thatch layer prior to turnover and final acceptance.
- F. Arborist: Provide a written report and recommendations as required by the Landscape Architect if any plant material is in the sole opinion of the Landscape Architect, declining, stressed, infested, or otherwise not growing at the anticipated growth rate. The report is to include Agronomic Soils Test Data and recommendations and be provided at no cost to the Owner.

### 3.06 GROUND COVER MAINTENANCE

- A. Watering:
1. Check for moisture penetration throughout the root zone at least twice a month.
  2. Water as frequently as necessary to maintain healthy growth of groundcovers.
- B. Weed Control:
1. Control weeds, preferably with pre-emergent herbicides and with selective systemic herbicides on a continuous weekly basis.
  2. Minimize hoeing of weeds in order to avoid damage to plant materials.

### 3.07 TREE, SHRUB, AND VINE MAINTENANCE

- A. Watering Basins:
1. Maintain watering basins around plant materials so that enough water can be applied to establish moisture through major root zone.
  2. In rainy seasons, open basins to allow surface drainage away from the root crown where excess water may accumulate. Restore watering basins at end of rainy season.
  3. For supplemental hand watering of watering basins, use a water wand to break the water force. Do not permit crown roots to become exposed to air through dislodging of soil and mulch.
  4. Maintain originally called for depth of mulch to reduce evaporation and frequency of watering.
  5. Check for moisture penetration throughout the root zone at least once per week.
- B. Resetting: Reset plant materials to proper grades or upright positions as required.
- C. Weed Control:
1. Control weeds, preferably by hand weeding; or with pre-emergent herbicides and with selective systemic herbicides.
  2. Areas between plants, including watering basins, shall be weed free on a continuous basis.
  3. Use only recommended and legally approved herbicides to control weed growth.
  4. Avoid frequent soil cultivation that destroys shallow roots and breaks the seal of pre-emergent herbicides.
- D. Pruning:
1. Provide Class I (thinning and shaping) of trees, including relocated and specimen trees greater than 15 feet in height, as requested by the Landscape Architect.
  2. Prune trees to select and develop permanent scaffold branches that are smaller in diameter than the trunk or branch to which they are attached, and which have vertical spacing of 18 inches to 48 inches and radial orientation so as not to overlay one another.

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3. Prune trees to maintain growth within space limitations only as directed by Landscape Architect, maintaining a natural appearance and balancing crown with roots.
4. Prune trees to eliminate diseased or damaged growth only as directed by Landscape Architect, and narrow V-shaped branch forks that lack strength. Reduce toppling and wind damage by thinning out crowns.
5. No stripping (raising up) of lower branches of young trees will be permitted.
6. Retain lower branches in a tipped back or pinched condition to promote caliper trunk growth, (tapered trunk). Do not cut back to fewer than six buds or leaves on such branches. Only cut lower branches flush with the trunk after the tree is able to stand erect without staking or other support.
7. Thin out and shape evergreen trees when necessary to prevent wind and storm damage. Do primary pruning of deciduous trees during the dormant season.
8. Prune damaged trees of those branches, which constitute health or safety hazards at any time of year as required.
9. Make cuts clean and close to the trunk, without cutting into the branch collar. 'Stubbing' will not be permitted. Cut smaller branches flush with trunk or lateral branch. Make larger cuts, (1 inch in diameter or larger), parallel to shoulder rings, with the top edge of the cut at the trunk or lateral branch.
10. Branches too heavy to handle shall be pre-cut in three stages to prevent splitting or peeling of bark. Make the first two cuts 18 inches or more from the trunk to remove the branch. Make the third cut at the trunk to remove the resulting stub.
11. Do not prune or clip shrubs into balled or boxed forms unless specifically called for by design.
12. Prune only as directed by Landscape Architect.

### E. Guying of Trees:

1. Inspect guys at least once a month to check for rubbing that causes bark wounds.
2. Conform to the recommended procedures of guying as outlined in the University of California Publication AXT-311, Staking Landscape Trees.

### F. Establishment of Existing Trees and Shrubs to Remain:

1. General: Conform to applicable paragraphs regarding pruning, watering, spraying and fertilizing of new plant materials as specified in this section.
2. Be alert to symptoms of construction damage to root systems of existing trees and shrubs as evidenced by wilting, unseasonable or early flowering or loss of leaves, and insect or disease infestation due to declining vigor.
3. Notify the Landscape Architect in writing of evidence of declining tree or shrub vigor immediately upon discerning the problem. Take appropriate interim measures to mitigate the severity of the problem as specified in this Section.
4. Submit in written proposal and cost estimate for the correction of conditions before proceeding with permitted correction work.

## 3.08 PALM MAINTENANCE

- ### A. Resetting:
- Reset palms to proper grades or upright position as required. Plumb palms as required due to settlement.

### B. Fertilization:

1. Initial Fertilization: Apply soluble palm fertilizer 6 to 8 weeks after installation during growing season (March through October).

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2. Fertilization Program (per gallon of water):
  - a. Six to eight weeks after installation, drench top of rootball (12 inch depth) with the following materials per gallon of water:
    - 1 quart Grow More Ferti-Plex 6 ounces Grow More (0-50-30) 6 ounces magnesium sulfate.
    - 2 fluid ounces of Essential (soluble biostimulant).
    - 2 fluid ounces of Companion (soluble biostimulant).
  - b. Two weeks after above soil drench treatment, drench the rootball with the following:
    - 2 fluid ounces of Essential (soluble biostimulant).
    - 2 fluid ounces of Companion (soluble biostimulant) 1 ounce Mycor Tree Palm Saver.
  - c. After second soil drench treatment, fertilize with Apex Palm Fertilizer (13-5-8) at 2 pounds per Palm.
  - d. Two weeks after above fertilization, drench the rootball with the following materials per 3 gallons of water:
    - 2 fluid ounces of Essential (soluble biostimulant).
    - 2 fluid ounces of Companion (soluble biostimulant).
- C. Pruning:
  1. Except for flower stalks, remove dead and/or desiccated fronds only.
  2. Chain saws are prohibited due to inability of sterilization of the hardware.
  3. Recommend loppers as the preferred pruning tool whenever possible over handsaws or shielded machetes due to the potential to spread sawdust.
  4. A sterilized, sharpened spade can be used to shape the 'Pineapple' and trunk.
  5. Pruning tools must be sterilized by a minimum five minute dip in a mixture of 50 percent Clorox Bleach and 50 percent water. Clorox is a 5.25 percent solution of sodium hypochlorite and water. When mixed 50/50 with water the mixture becomes a 2.25 percent solution of sodium hypochlorite.
  6. After dipping in sterilizing solution, rinse tools in a bucket of clean water or by spraying with clean water.
  7. Use two sets of tools, one to prune and the other to soak in the sterilizing solution. Switch the tools between palms, so that a sterilized tool is always ready for use.
  8. At the end of the work period, sterilize tools and rinse with water, dry and spray with WD-40 to prevent corrosion.
  9. Contractor shall take every precaution to safeguard caustic and irritating effect of Clorox on skin and eyes of tree workers with rubber gloves and safety glasses.
- D. Removal of Palm Tree Canopy Ties:
  1. Approximately 90 days after Preliminary Acceptance, remove dead or discolored fronds and frond canopy ties that were installed by the palm supplier that have not naturally broken free as part of the new canopy growth, as requested by the Landscape Architect.

### 3.09 IRRIGATION SYSTEM MAINTENANCE

- A. General:
  1. System Observation: Check systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each end of the lateral. Heads are to be adjusted as necessary for unimpeded head to head coverage.
  2. Valves: Set, and verify that pressure regulating valves to the operating pressure specified on the drawings.
  3. Controllers: Set and program automatic controllers for seasonal water requirements. Give the Owner's Representative instructions on how to turn off system in case of emergency.

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4. If the irrigation system is designed and specified to be operable from a central irrigation computer controller located off site, or a standard controller on site. Demonstrate to Landscape Architect, Owner's Representative, and future maintenance contractor that the central irrigation system is fully installed and operational from this off site control system as described and specified. Contractor shall make adjustments as necessary to ensure this operation prior to final acceptance.
  5. Repair, without charge to the Owner, damages to systems caused by Contractor's operations. Perform repairs within one watering period.
  6. Report promptly to Owner, accidental damage not resulting from Contractor's negligence or operations.
  7. Do not run the irrigation system during the rainy season. Set program and adjust automatic controllers for seasonal water requirements.
  8. Once a week, use a probe or other acceptable tool to check the rootball moisture of representative plant materials, as well as the surrounding soil.
- B. Set up and coordinate training for the maintenance contractor (provider) on the irrigation controller, and pump with the manufacturer's representative. Maintenance period shall not end, and Project will not be accepted until this training has been completed.
- C. Repairs: Repair damages to irrigation system at the Contractor's expense. Repairs shall be made within 24 hours or sooner to prevent damage to site improvements.
- D. Cleaning and Monitoring the System:
1. Continually monitor the irrigation systems to verify that they are functioning properly as designed. Make program adjustments required by changing field conditions.
  2. Clean pump filter and strainer at least once a year and as often as necessary to keep the irrigation systems free of sand and other debris.
- E. Provide maintenance of irrigation system consisting of cleaning nozzles, servicing valves, setting controller programs, and other activities required during the landscape maintenance period.
- F. Controllers: Set and program automatic controllers for seasonal water requirements. Give the Owner's representative instruction on how to turn off system in case of emergency.
- G. Repairs: Repair damages to irrigation system at the Contractor's expense. Repairs shall be made within 24 hours.
- H. Irrigation heads shall be adjusted to provide 100 percent coverage (head-to-head) with minimal overspray onto hardscape, paving, or vertical element.

### 3.10 INSECT, PEST, AND DISEASE CONTROL

- A. Watering:
1. Inspection: Inspect and protect plant materials for signs of stress, damage and potential trouble from the following:
    - a. Presence of insects, rabbits, moles, gophers, ground squirrels, snails and slugs in planting areas.
    - b. Discolored or blotching leaves, needles or fronds.
    - c. Unusually light green or yellowish green color inconsistent with normal green color of leaves, fronds or needles.
- B. Personnel: Perform spraying and removal for insect, pest and disease control only by qualified trained personnel.

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- C. Application: Spray with extreme care to avoid hazards to any person or pet in the area or adjacent areas.
- D. Palm Fungicide Drench: Apply fungicide drench to palm rootballs and sand backfill with 15 to 20 gallons of the following: Subdue Maxx and Cleary's 3366 mixed at the lower recommended rate. Reapply the fungicide at the same rate monthly for three months during the Maintenance Period.

### **3.11 FINAL ACCEPTANCE**

- A. Acceptance:
  - 1. Work will be accepted by the Landscape Architect upon satisfactory completion of work, including the replacement of plant materials under the Warranty Period.
  - 2. Submit a written request to the Landscape Architect for review for Final Acceptance at least five working days prior to anticipated Final Review date, which is at the end of the Maintenance Period.
- B. Corrective Work:
  - 1. Work requiring corrective action of replacement in the judgment of the Landscape Architect shall be performed within ten calendar days after the Preliminary Review and Acceptance.
  - 2. Corrective work and materials replacement shall be in accordance with the Specifications, and shall be made by the Contractor at no cost to the Owner.
  - 3. After corrective work is completed, the Contractor shall again request a Final Review for Final Acceptance as outlined above.
  - 4. Continue Maintenance until such time as corrective measures have been completed and accepted.
- C. Conditions for Acceptance of Work at End or Maintenance Period:
  - 1. Plant materials shall be alive and thriving, showing signs of growth and no signs of stress, disease, or any other weaknesses.
  - 2. Plant materials not meeting these conditions shall be replaced and a Ninety Day Maintenance Period commenced for such plant materials.
- D. Final Acceptance Date: The date on which the Landscape Architect issues a Letter of Final Acceptance shall constitute the Final Acceptance. Upon Final Acceptance, the Landscape Architect will assume responsibility for maintenance of the Work.

### **3.12 FINAL REVIEW**

- A. Conduct Final Review at the completion of the formal maintenance period.
- B. Submit a written request for review to the Landscape Architect 10 working days before the completion of work in order that a mutually agreeable time for review may be arranged.
- C. The Landscape Architect, Contractor, Owner, and others as the Landscape Architect will direct, shall be present at the Final Review.
- D. If, after the review, the Landscape Architect accepts that the work has been performed in accordance with the Contract Drawings and Specifications, and that plant materials are in satisfactory growing condition, and the irrigation system is in operating order, the Landscape Architect will issue written Notice of Final Acceptance and end of the formal maintenance period.
- E. Work requiring corrective action or replacement in the judgment of the Landscape Architect shall be performed within 10 days after the Final Review. Perform corrective work and replace materials in accordance with the Contract Drawings and Specifications.

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**3.13 ADJUSTING**

- A. General:
  - 1. Repair, without charge to the Owner, damages to systems caused by Contractor's operations. Perform repairs within one watering period.
  - 2. Report promptly to Owner, accidental damage not resulting from Contractor's negligence or operations.
  - 3. Do not run the irrigation system during the rainy season. Set and program automatic controllers for seasonal water requirements.
  - 4. Once a week, use a probe or other acceptable tool to check the rootball moisture of representative plant materials, as well as the surrounding soil.
- B. Immediately treat or replace plant materials, that become damaged or injured, as directed by Landscape Architect.
- C. Replacement plant materials shall be of a size, condition and variety acceptable to the Landscape Architect.

**3.14 CLEANING**

- A. Cleaning and Monitoring the System:
  - 1. Continually monitor the irrigation systems to verify that they are functioning properly as designed. Make program adjustments required by changing field conditions.
  - 2. Clean pump filter and strainer at least once a year and as often as necessary to keep the irrigation systems free of sand and other debris.
- B. Maintain planted areas free of debris. Cultivate and weed at intervals of not more than 14 calendar days.
- C. Broom or blow walks and paving areas, only, at intervals of not more than 7 calendar days.
- D. Upon completion of the maintenance period, leave landscaped areas clean and free of debris and weeds.

**3.15 PROTECTION**

- A. Protect planting areas and plants against damage for duration of maintenance period. Maintenance includes temporary protection fences, barriers, and signs as required for protection. If plants become damaged or injured, treat or replace as directed by Landscape Architect.

**END OF SECTION**

## SECTION 321216 - HOT-MIX ASPHALT PAVING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A This Section includes hot-mix asphalt paving, patching, and paving overlay.

#### 1.02 SUBMITTALS

- A Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C Material certificates.
- D Log of placement of asphalt, including dates, times, temperature readings and other pertinent information.

#### 1.03 QUALITY ASSURANCE

- A Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC) and the California Department of Transportation (Caltrans), latest editions and supplements for asphalt paving work. These Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.
- C Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

#### 1.04 PROJECT CONDITIONS

- A Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
  - 1. Tack Coat: Minimum surface temperature of 60 degrees Fahrenheit.
  - 2. Asphalt Base Course: Minimum surface temperature of 40 degrees Fahrenheit and rising at time of placement.
  - 3. Asphalt Surface Course: Minimum surface temperature of 60 degrees Fahrenheit at time of placement.
- B Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees Fahrenheit for oil-based materials, 50 degrees Fahrenheit for water-based materials, and not exceeding 95 degrees Fahrenheit.

### PART 2 PRODUCTS

#### 2.01 AGGREGATES

- A Coarse and fine aggregate shall conform to SSPWC section 203-6.2.2. Mineral filler, if required, shall conform to SSPWC section 203-6.2.4.

#### 2.02 ASPHALT MATERIALS

- A Asphalt Binder: Paving asphalt, viscosity grade PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications.

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- B Tack Coat: PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications.
- C Mixes: Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mix III-C3 PG 64-10 designed in conformance with SSPWC Section 203-6.5.

### 2.03 AUXILIARY MATERIALS

- A Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with Caltrans Standard Specifications - Section 84 (Federal Specification No. TT-P-1952 for Blue, Red and Green paint; and State of California Standard Specification No. PTWB-01 for White, Yellow and Black paint) with drying time of less than 45 minutes.
  - 1. Color: As indicated.
- C Wheel Stops: Precast, air-entrained concrete
  - 1. Dowels: Galvanized steel, one-half-inch diameter, 18-inch minimum length.

## PART 3 EXECUTION

### 3.01 COLD MILLING

- A Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
  - 1. Mill to a depth of two inches.

### 3.02 PATCHING

- A Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gallons/square yard.
- C Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

### 3.03 SURFACE PREPARATION

- A Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- B Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
  - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- C Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- D Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gallons/square yard.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

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2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings.  
Remove spillages and clean affected surfaces.

**3.04 HOT-MIX ASPHALT PLACING**

- A Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  1. Spread mix at minimum temperature of 250 degrees Fahrenheit.
  2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

**3.05 COMPACTION**

- A General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
  1. Complete compaction before mix temperature cools to 185 degrees Fahrenheit.
- B Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- F Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

**3.06 INSTALLATION TOLERANCES**

- A Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  1. Base Course: Plus or minus one-half inch.
  2. Surface Course: Plus one-fourth inch (no minus).
- B Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  1. Base Course: One-fourth inch.
  2. Surface Course: One-eighth inch.

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3. Crowned Surfaces: Test with crowned template centered and at right angle to crown.  
Maximum allowable variance from template is one-fourth inch.

**3.07 PAVEMENT MARKING**

- A Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B Allow paving to age for 30 days before starting pavement marking.
- C Sweep and clean surface to eliminate loose material and dust.
- D Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

**3.08 WHEEL STOPS**

- A Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel one inch beneath top of wheel stop.

**3.09 FIELD QUALITY CONTROL**

- A Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

**3.10 DISPOSAL**

- A Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

**END OF SECTION**

**HOT-MIX ASPHALT PAVING - 321216**

## SECTION 321236 – EMULSIFIED SLURRY SEAL

### PART 1 GENERAL

#### 1.01 SUMMARY

- A The work shall consist of mixing asphaltic emulsion, aggregate, set-control additives and water, and spreading the mixture on a surfacing or pavement.

#### 1.02 SUBMITTALS

- A Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B Asphaltic Emulsion: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C Material certificates.
- D Log of slurry seal application, including dates, times, temperature readings and other pertinent information.

#### 1.03 QUALITY ASSURANCE

- A Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
- B Standard Specifications: Comply with latest editions and supplements for Caltrans Standard Specifications Sections 37 and 94. These Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

#### 1.04 PROJECT CONDITIONS

- A Environmental Limitations: The slurry seal shall not be applied if either the pavement or air temperature is below 50 degrees Fahrenheit. and falling, but may be applied when both pavement and air temperatures are above 45 degrees Fahrenheit and rising. No slurry seal shall be applied when there is a possibility of freezing temperatures at the project location within 24 hours after application.
- B Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees Fahrenheit for oil-based materials, 50 degrees Fahrenheit for water-based materials, and not exceeding 95 degrees Fahrenheit.

### PART 2 PRODUCTS

#### 2.01 ASPHALTIC EMULSION

- A Asphaltic emulsion shall be a quick-setting type, grade QS1h anionic, or grade CQS1h cationic, conforming to the provisions in Caltrans Standard Specifications Section 94, Table 4. The grades of asphaltic emulsion shall be at the option of the Contractor.

#### 2.02 AGGREGATE

- A Aggregate shall conform to the provisions in Caltrans Standard Specification Section 37-3.01A(4)(c), Type **[I] [II] [III]**.
  - 1. Type I: This aggregate gradation is used to fill surface voids, address moderate surface distresses, and deliver protection from the elements. The fineness of this mixture allows the ability for some crack penetration.

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2. Type II: This aggregate gradation is used to fill surface voids, address more severe surface distresses, seal, and deliver a durable wearing surface.
3. Type III: This aggregate gradation delivers maximum skid resistance and an improved wearing surface.

### 2.03 WATER

- A Water shall be such quality that the asphalt will not separate from the emulsion before the slurry seal is in place in the work. If necessary for workability, a set-control agent that will not adversely affect the slurry seal may be used.

### 2.04 MIX DESIGN

- A Compatibility of the emulsified asphalt, aggregate, water and additives shall be evaluated in the mix design. The slurry seal mixture shall conform to the requirements specified when tested in accordance with the Caltrans Standard Specifications Section 37-2.03.

### 2.05 PAVEMENT MARKING PAINT

- A Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with Caltrans Standard Specifications - Section 84 (Federal Specification No. TT-P-1952 for Blue, Red and Green paint; and State of California Standard Specification No. PTWB-01 for White, Yellow and Black paint) with drying time of less than 45 minutes.
1. Color: As indicated..

## PART 3 EXECUTION

### 3.01 SURFACE PREPARATION

- A Prior to applying the slurry seal, loose material, oil spots, vegetation, and other objectionable material shall be removed. A standard cleaning method such as sweeping, flushing, or other means will be acceptable. If water is used, cracks shall be allowed to dry thoroughly before slurry surfacing. Manholes, valve boxes, catch basins, and other utility boxes shall be protected from slurry seal by a suitable method.
- B Treat cracks wider than 0.25 inches in the pavement surface with an approved crack sealer prior to application of slurry seal.

### 3.02 PLACING

- A The slurring mixture shall be uniformly spread on the existing surfacing within the rate specified without spotting, re-handling or otherwise shifting of the mixture.
- B Slurry seal shall not be placed when the atmospheric temperature is below 50 degrees Fahrenheit or during unsuitable weather.
- C Slurry seal shall be spread at a rate specified in Caltrans Standard Specifications Section 37-2.06.
- D The mixture shall be uniform and homogeneous after spreading on the existing surfacing and shall not show separation of the emulsion and aggregate after setting.
- E Lumping, balling, or unmixed aggregate will not be acceptable.
- F Adequate means shall be supplied to protect slurry seal from damage by traffic until such time that the mixture has cured sufficiently so that the slurry seal will not adhere to and be picked up by the tires of vehicles.

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- G No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or traverse joints. The contractor shall supply suitable equipment to produce a minimum number of longitudinal joints throughout the project. When possible, a longitudinal joint shall not be placed in a wheel path. Less than full box width passes will be used only as required. If less than full box width passes are used, they shall not be the last pass of any paved area. A maximum of six inches shall be allowed for overlap of longitudinal joints.
- H Area which cannot be accessed by the mixing machine shall be surfaced using hand squeegees to allow complete and uniform coverage. If necessary, the area to be handworked shall be lightly dampened prior to mix placement. Handwork shall exhibit the same finish as that applied by the spreader and shall be completed prior to final surfacing.
- I Care shall be taken to apply straight lines along curbs and gutters. No run-off on these areas will be permitted. Roofing felt or heavy plastic may be used to begin or end a pull cleanly.
- J Rolling is not necessary for slurry seal on roadways. Parking areas shall be rolled by a self-propelled, 10-ton (maximum) pneumatic tire roller equipped with a water spray system. All tires shall be inflated per manufacturer's specifications. Rolling shall not start until the slurry has cured sufficiently to avoid damage by the roller. Areas which require rolling shall receive a minimum of two full coverage passes.

### 3.03 PAVEMENT MARKING

- A Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B Allow paving to age for 30 days before starting pavement marking.
- C Sweep and clean surface to eliminate loose material and dust.
- D Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to allow a minimum wet film thickness of 15 mils.

### 3.04 FIELD QUALITY CONTROL

- A Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C Remove and replace or install additional slurry seal mixture where test results or measurements indicate that it does not comply with specified requirements.

### 3.05 DISPOSAL

Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an Environmental Protection Agency (EPA) approved landfill.

**END OF SECTION**

**EMULSIFIED SLURRY SEAL - 321236**

## SECTION 321313 – CONCRETE PAVING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A This Section includes exterior cement concrete pavement for the following:
  - 1. Driveways and roadways.
  - 2. Parking lots.
  - 3. Curbs and gutters.
  - 4. Walkways.

#### 1.02 SUBMITTALS

- A Product Data: For each type of product indicated, including admixtures.
- B Design Mixtures: For each concrete pavement mixture.

#### 1.03 QUALITY ASSURANCE

- A Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- C All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
- D The Contractor shall have one copy of the Standard Specifications at the job site.
- E The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.

### PART 2 PRODUCTS

#### 2.01 STEEL REINFORCEMENT

- A Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- C Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

#### 2.02 CONCRETE MATERIALS

- A Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
  - 1. Portland Cement: ASTM C 150, Type II, low alkali. Supplement with the following:
    - a. Pozzolan: ASTM C 618, Class F or N Fly Ash, 100 pounds maximum per cubic yard, containing one percent or less carbon. Fly ash shall not be used in excess of 15 percent by weight of total cement quantity.
- B Combined Aggregates: Gradation "C" conforming to SSPWC Section 201-1.3.2.
- C Water: ASTM C 94/C 94M.

#### 2.03 CURING MATERIALS

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- A Liquid Curing Compound: ASTM C309, fugitive dye dissipating type, complying with Rule II 13 of the South Coast Air Quality Management District and Federal Air Quality Regulation 40 CFR 52.254.
- B Moisture-Retaining Cover (Curing Sheet): ASTM C 171, non-staining polyethylene film or white burlap-polyethylene sheet.
- C Water: Potable.
- D Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

### 2.04 RELATED MATERIALS

- A Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
- C Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- D Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with Caltrans Standard Specifications - Section 84 (Federal Specification No. TT-P-1952 for Blue, Red and Green paint; and State of California Standard Specification No. PTWB-01 for White, Yellow and Black paint) with drying time of less than 45 minutes.
  - 1. Color: As indicated.

### 2.05 WHEEL STOPS

- A Wheel Stops: Precast, air-entrained concrete.
  - 1. Dowels: Galvanized steel, one-half-inch diameter, 18-inch minimum length.

### 2.06 CONCRETE MIXTURES

- A Prepare design mixtures, proportioned according to ACI 301, with the following properties:
  - 1. Compressive Strength (28 Days): Minimum **2,500 pounds per square inch (psi)**  
Maximum 3,250 pounds per square inch (psi)
  - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.60.
  - 3. Slump Limit: Four inches, plus or minus one inch.
- B Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions.

### 2.07 CONCRETE MIXING

- A Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates to Architect for each batch discharged and used in the Work.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

### 3.02 EDGE FORMS AND SCREED CONSTRUCTION

- A Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

**3.03 STEEL REINFORCEMENT**

- A General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

**3.04 JOINTS**

- A General: Form construction, isolation, and control joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
- B Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
- C Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
- D Control Joints: Form weakened-plane control joints, sectioning concrete into areas as indicated. Within 24 hours of pour, construct control joints for a depth equal to at least one-fourth of the concrete thickness **[to match jointing of existing adjacent concrete pavement]**.
- E Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a one-fourth-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

**3.05 CONCRETE PLACEMENT**

- A Moisten subbase to provide a uniform dampened condition at time concrete is placed.
- B Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D Screed pavement surfaces with a straightedge and strike off.
- E Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

**3.06 FLOAT FINISHING**

- A General: Do not add water to concrete surfaces during finishing operations.
- B Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
- C **Finish to be chosen by Landscape Architect**
  - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.



2. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
  3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface one-sixteenth to one-eighth inch deep with a stiff-bristled broom, perpendicular to line of traffic.
- D Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface according to manufacturer's written instructions.
1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
  2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

**3.07 CONCRETE PROTECTION AND CURING**

- A General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B Comply with ACI 306.1 for cold-weather protection.
- C Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds/square feet x h before and during finishing operations. Apply according to manufacturers written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- D Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these methods.

**3.08 PAVEMENT TOLERANCES**

- A Comply with tolerances as follows
1. Elevation: One-fourth inch.
  2. Thickness: Plus three-eighths inch minus one-fourth inch.
  3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed one-fourth inch.
  4. Joint Spacing: Three inches.
  5. Contraction Joint Depth: Plus one-fourth inch no minus.
  6. Joint Width: Plus one-eighth inch, no minus.

**3.09 PAVEMENT MARKING**

- A Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- C Sweep and clean surface to eliminate loose material and dust.
- D Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

**3.10 WHEEL STOPS**

- A Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel one inch beneath top of wheel stop.

**3.11 REPAIRS AND PROTECTION**

- A Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.
- C Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION**

**SECTION 321314 – EXPOSED AGGREGATE CONCRETE PAVING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Acid-washed exposed aggregate, integrally colored, proprietary architectural concrete paving finish system incorporating a patented process.
  - 1. Include designated paving, accessible concrete ramps, and stairs as indicated on the Contract Drawings.
- B. Related Sections:
  - 1. Section 012500 - Substitution Procedures.
  - 2. Section 013300 - Submittal Procedures.
  - 4. Section 031000 - Concrete Forming and Accessories.
  - 5. Section 079200 - Joint Sealants.
  - 6. Section 321313 - Concrete Paving.
- C. Alternatives: The work of this Section may be affected by alternatives described in Section 012300.

**1.02 REFERENCES**

- A. ASTM International (ASTM):
  - 1. A 82 - Specification for Steel Wire, Plain, for Concrete Reinforcement.
  - 2. A 615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 3. C 33 - Specification for Concrete Aggregates.
  - \*4. C 94 - Specification for Ready-Mixed Concrete.
  - 5. C 150 - Specification for Portland Cement.
  - 6. C 157 - Test Method for Length Change of Hardened Hydraulic Cement, Mortar, and Concrete.
  - 7. C 260 - Specification for Air-Entraining Admixtures for Concrete.
  - 8. C 494 - Specification for Chemical Admixtures for Concrete.
  - 9. C 618 - Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
  - 10. C 979 - Specification for Pigments for Integrally Colored Concrete.
  - 11. C 1017 - Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
  - 12. C 1116a - Specification for Fiber-Reinforced Concrete.
  - 13. E 329 - Specification for Agencies Engaged in Construction Inspection, or Special Testing.
- B. California Code of Regulations (CCR):
  - 1. CBSC, Title 24, Part 2- California Building Code (CBC), 2019 edition.
    - a. Chapter 11B - Accessibility to Public Buildings, Public Accommodations, Commercial Buildings, and Public Housing:
      - 1) Division 3 - Building Blocks.
        - a) Section 11B-302 - Floor or Ground Surfaces.
          - (1) 11B-302.1 - General.
- C. California Code of Regulations (CCR):
  - 1. CBSC, Title 24, Part 11 - California Green Building Standards Code (CALGreen), 2019 edition.

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- D. American Concrete Institute (ACI), latest edition:
  - 1. 301 - Specifications for Structural Concrete for Buildings.
    - a. SP-15 - Field Reference Manual: Specifications for Structural Concrete for Buildings ACI 301 with Selected ACI and ASTM References.
  - 2. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
  - 3. 305R - Hot Weather Concreting.
- E. California Occupational Safety and Health Standards (OSHA).
  - 1. Article 6 - Excavations and Shoring.
- F. National Floor Safety Institute (ANSI/NFSI):
  - 1. ANSI/NFSI B101.1 - Test Method for Measuring Wet SCOF of Common Hard-Surface Floor Materials.
- G. Portland Cement Association (PCA).
  - 1. Design and Control of Concrete Mixes.
- H. United States Green Building Council (USGBC):
  - 1. Leadership in Energy and Environmental Design (LEED):
    - a. Green Building Rating System.

### 1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate with applicable Credit descriptions for more specific procedural requirements of Section 018113.
- B. Coordination: Coordinate work of this Section with walkway and pedestrian paving patterns specified in Section 321313.
- C. Preconstruction Meeting:
  - 1. Attend a Pre-Construction Meeting on site organized by General Contractor or Construction Manager at last two weeks prior to beginning of work with Owner, Contractor, Construction Manager, Architect, Landscape Architect, and subcontractors that may be affected by Contractor's work.
  - 2. Record and distribute relevant meeting minutes based on preconstruction meeting which include decisions, directions, and agreements reached that effect concrete paving work.
  - 3. Review methods and procedures related to work of this Section, including, but not limited to:
    - a. Required testing, inspections, reviews, and procedures for approvals.

### 1.04 SUBMITTALS

- A. Product Data: In accordance with the provisions of Section 013300, submit complete supplier's descriptive literature and specifications.
- B. Shop Drawings:
  - 1. Submit Shop Drawings for reinforcing steel and accessories in accordance with ACI standards.
  - 2. Submit paving joint and pour sequence plan indicating the following:
    - a. Proposed layout of contraction, construction, and isolation joints. Clearly delineate the three different joint types.
    - b. Layout of paving types as indicated on Paving Schedule in Civil Contract Drawings. Give overall dimensions of each paving type.
    - c. Concrete pour sequence.

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- C. Samples: In accordance with the provisions of Section 013300, submit the supplier's standard finishes palette, for selection.
  - 1. When selection has been made, submit samples of finish not less than 12 inches by 12 inches by 1 inches thick for final review and acceptance.
- D. Quality Control Submittals:
  - 1. Design Data: Submit mix design prepared by batch plant servicing Project for each load delivered to Project. Statement of Mix Design to contain following information:
    - a. Project location.
    - b. Contractor requesting load delivery.
    - c. Name, address, and telephone number of batch plant preparing statement of mix design.
    - d. Date of mix design.
    - e. Mix design number.
    - f. Gradation for sand and aggregate.
    - g. Integral color used.
    - h. Basis of testing.
    - i. Material weights, specific gravity, and absolute volumes.
    - j. Water/cement ratio.
    - k. PSI rating.
    - l. Signature of testing laboratory manager.
    - m. Signed stamp from registered Project structural engineer or Architect.
  - 2. Test Reports: Submit concrete test reports.
  - 3. Supplier's Instructions: Submit copy of supplier's recommended installation instructions.
  - 4. Installers: Submit qualifications and background information for architectural cast-in-place subcontractor certified by paving patent holder. Furnish evidence to indicate successful experience in providing concrete work identical to that specified herein, including a listing of projects as comparable projects to the specified work prior to award of bid.
    - a. Qualifications must comply with the requirements and approval of paving patent holder.

### 1.05 EXTRA STOCK MATERIALS

- A. Surface-Seeded Aggregate: Submit:
  - 1. One 1-pound sample of each aggregate type specified.
  - 2. One 100-pound sealed bag of each aggregate type specified.
- B. Washed Concrete Sand: Submit:
  - 1. One 50-pound sealed bag of washed concrete sand similar to type used during installation of exposed aggregate concrete paving.
- C. Cement: One sealed 5-gallon container of portland cement for each paving type installed. Cement shall have been produced from the same batch as the cement used for the project.
- D. One copy of each concrete mix design for each paving type specified on Drawings. A Concrete Mix Design will assist in achieving a better concrete match should paving repairs be made in the future.
- E. Supplier's paving operations and maintenance manual.
- F. Supplier's warranties.

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**1.06 QUALITY ASSURANCE**

- A. Installer's Qualifications: Employ experienced architectural cast-in-place concrete paving installers, franchised, licensed, certified, or otherwise authorized by supplier of product proposed for use.
  - 1. Supervision: On site superintendent must have a minimum of 5 years experience installing exposed aggregate concrete paving proposed for use.
- B. Testing Agency: A testing agency may be designated by Owner. Testing personnel shall meet qualification requirements ASTM E 329.
- C. Certifications:
  - 1. Mixes shall be designed by a commercial testing laboratory acceptable to the Architect, using approved materials furnished by the Contractor to obtain the specified minimum compressive strengths.
- D. Mockups:
  - 1. Prior to construction, provide one sample of each paving type as specified on Contract Drawings.
  - 2. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
  - 3. Build mockups of concrete paving in each color and finish specified with respective score/sawcut and expansion/isolation joints in the location and of the size indicated or, if not indicated build mockups where directed by the Architect and not less than 4' x 4' x 4" thick. Include full size truncated dome system.
  - 4. Upon request, the Architect may require modifications to be made to the mockups. The revised mockups shall be provided at no additional cost to owner. Once mockups have been approved by the Architect, Contractor shall retain approved mockups during construction as standard for judging completed work.
  - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 6. Approved mockups may not become part of completed Work.
  - 7. Remove mock-ups from site upon completion of Work and approval by Architect.

**1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials in a dry and protected location. Protect reinforcing steel and dowels from rusting, deformation, staining, and moisture damage.
- B. Protect reinforcing steel, dowels, and tie wire, from rusting, deformation, staining, and moisture damage.

**1.08 FIELD CONDITIONS**

- A. Ambient Conditions: Perform the work of this Section under environmental conditions no less stringent than those stipulated by the supplier.
- B. Keep Work area clean, and in a safe and organized condition so that rubbish, waste, and debris do not interfere with work of other trades.
- C. Provide acid containment area in accordance with CAL OSHA during acid washing operations. Refer to Manufacturer Safety Data Sheets (MSDS).

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### 1.09 WARRANTY

- A. In addition to manufacturer's guaranties for products installed in conjunction with this Section, warrant architectural concrete paving for a period of one year from date of Substantial Completion by Owner against defects in materials, workmanship, and damage caused by installer's negligence.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Design is based on the use of exposed aggregate concrete paving system patented and supplied by one of the following:
1. J&M Concrete Construction (Intecrete), Orange, CA (714)978-2222, [www.jmcontractors.com](http://www.jmcontractors.com).
  2. Shaw & Sons Concrete (Lithocrete), Costa Mesa, CA, Contact: Jeff Counterman (949)642-0660.
- B. Design is based on the use of integral color admixture products manufactured by the following:
1. Admixtures, Inc., Irwindale, CA (626)357-3263, <http://admixtures.biz>.
  2. BASF, [www.basf-admixtures.com](http://www.basf-admixtures.com).
  3. Brickform, [www.brickform.com](http://www.brickform.com).
  4. Classic Coating Systems, [www.classiccoatingsystems.com](http://www.classiccoatingsystems.com)
  5. Davis Colors, Los Angeles, CA (323)269-7311, [www.daviscolors.com](http://www.daviscolors.com).
  6. L.M. Scofield Company, Los Angeles, CA (213)725-7112 (800)800-9900.
  7. QC, (800)453-8213.
  8. Solomon Colors, Rialto, CA (909)873-9444, (866)747-2656, (800)624-0261, [www.solomoncolors.com](http://www.solomoncolors.com).
- C. Design is based on the use of other admixture products manufactured by the following:
1. BASF Corporation Construction Chemicals, Cleveland, OH (216)839-7500 (800)628-9990, [www.basf-admixtures.com](http://www.basf-admixtures.com).
  2. Grace Construction Products, division of W.R. Grace and Co.-Conn., Cambridge, MA (617)876-1400, (800)892-1165, with sales offices in Costa Mesa, CA (800)852-0568, [www.graceconstruction.com](http://www.graceconstruction.com).
  3. Euclid Chemical Company; [www.euclidchemical.com](http://www.euclidchemical.com).
  4. Hycrete; [www.hycrete.com](http://www.hycrete.com).
- D. Design is based on the use of accessory products manufactured by the following:
1. Admixtures, Inc., Irwindale, CA (626)357-3263, <http://admixtures.biz>.
  2. BASF; [www.basf-admixtures.com](http://www.basf-admixtures.com).
  3. Pacific Concrete Images; [www.pacificconcreteimages.com](http://www.pacificconcreteimages.com)
  4. Brickform; [www.brickform.com](http://www.brickform.com).
  5. Classic Coating Systems; [www.classiccoatingsystems.com](http://www.classiccoatingsystems.com)
  6. Greenstreak, St. Louis, MO (800)225-9400, represented by Speed Dowel, Inc., Costa Mesa, CA (800)773-6935, [www.greenstreak.com](http://www.greenstreak.com).
  7. Floric Polytech; [www.floricpolytech.com](http://www.floricpolytech.com).
  8. Grace Construction Products; [www.na.graceconstruction.com](http://www.na.graceconstruction.com).
  9. Sinak Corporation, San Diego, CA (619)231-1771.
  10. White Cap, Inc., Santa Ana, CA (714)258-3300.
  11. Euclid Chemical Company; [www.euclidchemical.com](http://www.euclidchemical.com).
  12. Hycrete; [www.hycrete.com](http://www.hycrete.com)
  13. Master Builders; [www.masterbuilders.com](http://www.masterbuilders.com).

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14. New Look International; [www.getnewlook.com](http://www.getnewlook.com).

15. Smith Paint Products; [www.smithpaints.com](http://www.smithpaints.com).

### 2.02 REGULATORY REQUIREMENTS

#### A. Regulatory Requirements:

1. Comply with CBC Section 1133B.7.1 requirements for slip resistance.

- a. Concrete paving shall have a minimum slip resistance coefficient of friction of 0.6 as tested in accordance with ASTM C 1028 or ASTM D 2047.

### 2.03 DESIGN CRITERIA

A. Design Requirements: Integrally colored exposed aggregate concrete complying with integral color admixture supplier's instructions and recommendations for mixing, placing, floating, troweling, scoring, cutting, curing, washing, finishing, and application of set retarder.

B. Intecrete finish system is covered by US Patents No. 4,228,217 and is patent-pending.

1. Pay all royalties required in connection with use of this product.

C. Lithocrete finish system is covered by US Patents No. 6,033,146, No. 6,016,635, No. 7,322,772-B2, No. 7,607,859-B2, and U.S. Trademarks No. 1,873,329, No. 2,358,183 No. 2,358,054, and No. 3,446,898 based on proprietary formulation by Shaw & Sons Concrete.

1. Pay all royalties required in connection with use of this product.

### 2.04 CONCRETE MATERIALS, GENERAL

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces. Provide adequate bracing in conformance with the general material requirements of Section 031000.

#### 1. Straight Sections:

- a. No 2 construction grade S4S Douglas Fir minimum 1-1/2-inches thick, free of warping, loose knots, cupping, checks, bows, cracks, and other imperfections that would produce objectionable defects in finished work.
- b. Depth of forms to be same depth as concrete being placed.
- c. Form work to be new lumber or re-used lumber that has been cleaned of residual concrete and laitance. Treat new or re-used form work with Wood Form Release prior to placing concrete.

#### 2. Curved Sections:

- a. Use 1-1/2-inch bender or back-cut boards or 1/2-inch wood siding, installed with sufficient bracing for construction of curved formwork.

#### B. Reinforcing Materials:

1. Reinforcing Steel: Grade 60 steel conforming to ASTM A 615, clean and free of rust, dirt, grease or oils.
2. Tie Wire: 16-gauge plain cold-drawn steel conforming to ASTM A 82, clean, and free of rust, dirt, grease or oils.
3. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars in place.
4. Polypropylene Fiber Reinforcement: 100% virgin multifilament polypropylene fibers, complying with ASTM C 1116, Type III, 1/4-inch long, 1/2 lb./cy of mix application rate.
  - a. Acceptable Manufacturers:
    - 1) Fibermesh 150 (formerly Stealth e3) by Propex Concrete Systems.
    - 2) PSI Fiberstrand 100 by Euclid Chemical.

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- 3) MicroFiberT by Grace Construction Products.
  - 4) UltraFiber 500 by Buckeye Building Fibers.
- C. Concrete Materials: As required by supplier of proprietary color additive and aggregate.
1. Portland Cement: ASTM C 150, Type II/V. All cement shall be the same brand from a single source throughout entire project to ensure consistency of visual appearance.
  2. Aggregate: ASTM C 33, uniformly graded and clean.
    - a. Coarse Aggregate: Crushed rock or washed gravel with maximum size between 3/8-inch and one inch in size. All coarse aggregate shall be from single source and of like visual appearance.
      - 1) Use same aggregate from single source throughout entire project.
    - b. Fine Aggregate: Natural washed Foster-Corona concrete sand of hard and durable particles varying from fine to particles passing a 3/8-inch screen, of which at least 12 percent shall pass a 50-mesh screen. Provide all sand from a single source of like visual appearance.
      - 1) Use same sand from single source throughout entire project.
      - 2) Foster-Corona sand suppliers:
        - a) National Redi-Mix (949)552-5566.
        - b) Robertson Redi-Mix (800)834-7557.
        - c) Other local batch plants.
  3. Exposed Seeded Aggregate: ASTM C 33, Select aggregate mixture from a single source and as specified on Contract Drawings.
    - a. Provide surface-seeded aggregate in type, size, color, and distribution percentage matching supplier's sample as selected by Architect.
    - b. Use surface-seeded aggregate from same source for each paving type specified throughout entire project.
- D. Fly Ash: ASTM C 618 Type F with low carbon content and less than 3 percent loss on ignition.
1. Ensure that fly ash does not cause color discrepancies in alternate slab pours.
- E. Water: Potable water free from deleterious materials such as oils, acids, and organic matter.

### 2.05 MATERIALS AND EQUIPMENT, LITHOCRETE

- A. Admixtures: Use only admixtures included in mix design.
1. Chemical Admixtures: Comply with ASTM C 494 and ASTM C 1017.
  2. Integral Color Admixture: Proprietary formulation by Shaw & Sons, covered by US Patent No. 4,748,788 and complying with ASTM C 979. Water reducing components shall conform to ASTM C 494.
  3. Concrete color shall be manufactured by L.M. Scofield, Colorfull by Admixtures, Inc., Davis Color, QC, or equal by Solomon Colors.
  4. Water Reducing Admixtures: Conforming to ASTM C 494, Type A.
    - a. Grace Construction Products; Daravair, Master Builders (BASF) Micro-Air, or equal.
  5. Shrinkage Reducing Admixtures: Conforming to ASTM C 157.
    - a. Grace Construction Products Eclipse Shrinkage Reducing Admixture, or equal by BASF.
  6. Admixtures which result in more than 0.1 percent soluble chloride ions by weight of cement are prohibited.
- B. Accessories:
1. Set Retarder: As recommended by supplier of integrally colored admixture.

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2. Acid Washing Solution: As recommended by supplier of integrally colored admixture. Comply with applicable industrial safety and environmental protection regulations and statutes.
  3. Curing Compound: Colorfull, as manufactured by Admixtures Inc.
  4. Curing Materials: Polyethylene sheeting and other moisture-retaining products as recommended by supplier of integrally colored admixture.
  5. Expansion Joint Filler: Ethafoam Polyfelt, as manufactured by White Cap.
  6. Sealant: Two-part polyurethane, Types A1 and A2, as specified in Section 079200.
  7. Dowel Sleeves: Speed Dowel 1/2-inch diameter by 12-inch long two-piece polypropylene plastic sleeve, manufactured by Greenstreak, or equal.
    - a. Dowels: 1/2-inch-diameter smooth dowel free of dirt, grease, and oils.
  8. Conditioner: As recommended by supplier.
  9. Etching Solution: As recommended by supplier.
  10. Sealer: As recommended by supplier.
  11. Waterproofing Sealer: Sinak HLQ-125.
- C. Equipment: Provide type, size, and quantity of paving equipment to complete work within the requirements of the accepted construction schedule. Specialized installation equipment available from supplier are as follows:
1. Lithocrete Vibrating Float Process (U.S. Patent No. 6,016,635).
  2. Lithocrete Power Trowel Process (U.S. Patent No. 6,016,635).
  3. Presto Pneumatic Spray Process (U.S. Patent No. 7,670,081-B2).

### 2.06 MATERIALS, INTECRETE

- A. Proprietary Products: Intecrete concrete paving system incorporates several proprietary products, some of which are included in the following:
1. Intecrete Aggregates: Provided by Intecrete Contractor from the same source throughout duration of Project.
  2. Alkali-Silica Reactivity (ASR) Mitigation: Intecrete Protect LNTM.
  3. Intecrete Aggregate Exposure: Intecrete Reveal.
  4. Intecrete Surface Cleaner: Intecrete CleanEtch.
  5. Intecrete Paving Sealers:
    - a. Penetrating Sealer and Stain Reducer: Intecrete PeneSeal Clear (Prosoco Siloxene PD), clear and invisible with no color enhancement.
    - b. Surface Sealer, Matte: Intecrete PeneSeal Matte (Prosoco Guard EXT or Prosoco Paver Enhance WB), matte finish with slight color enhancer.
    - c. Surface Sealer, Gloss: Intecrete PeneSeal Gloss, gloss, color with high color enhancer.
  6. Intecrete Paving Densifier and Efflorescence Reducer: Intecrete Densify, to densify concrete surface and reduce abrasion.
- B. Admixtures:
1. Color Pigments: Integral Liquid Color:
    - a. Synthetic, color stable, non-fading, mineral oxide pigments conforming to ASTM C 979.
    - b. Liquid color pigments added to concrete to produce consistent, decorative color dispersion.
    - c. Provide specific colors and manufacturer of pigments as indicated on Drawings. Specified pigment manufacturer may be substituted with an alternative manufacturer during as outlined in Section 012500.
    - d. Colors: As selected by Architect from supplier's standard color palette.

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- e. Acceptable Manufacturers:
  - 1) HydroTint by Davis Colors.
  - 2) Rheocolor L by BASF.
  - 3) ColorFlo by Solomon Colors.
  - 4) Chromix L by L.M. Scofield.
- 2. Color Hardeners, Surface-Applied:
  - a. Dry, cementitious color pigments of high opacity conforming to ASTM C 979 and topically applied to freshly-placed concrete.
  - b. Acceptable Manufacturers:
    - 1) Dustone™ Color Hardener by Pacific Concrete Images
    - 2) Lithochrome Color Hardener by Scofield.
    - 3) Colorfull Color Hardener by Admixtures.
    - 4) Brickform Color Hardener by Brickform.
    - 5) Floric Polytech.
- 3. Set Modifiers: Accelerating Set Modifiers: Non-corrosive, non-chloride admixture for placing concrete during cold weather conditions or to provide additional placement time resulting in shortened set time and increased early compressive strength.
  - a. Acceptable Manufacturers:
    - 1) PolarSet by Grace Construction Products;.
    - 2) Pozzolith 122 HE by BASF.
    - 3) AccelGuard AcN 200 by Euclid Chemical Company.
- 4. Retarding Set Modifiers: Aqueous-based admixture designed to control concrete set times during hot weather conditions or extend concrete delivery times.
  - a. Acceptable Manufacturers:
    - 1) Recover by Grace Construction Products.
    - 2) Pozzolith 122 HE by BASF.
    - 3) Eucon HC by Euclid Chemical Company.
- 5. Water Reducers: Conforming to C 494 Type A and D, added to concrete to lower concrete water content to achieve greater plasticity and increased compressive strength.
  - a. Acceptable Manufacturers:
    - 1) WRDA by Grace Construction Products.
    - 2) Equal product by BASF.
    - 3) Equal product by Euclid Chemical Company.
- 6. Shrinkage Reducers: Added to concrete to reduce concrete shrinkage and curling due to evaporation.
  - a. Acceptable Manufacturers:
    - 1) Eclipse by Grace Construction Products.
    - 2) Eucon SRATM by Euclid Chemical Company.
    - 3) Tetraguard by BASF.
- 7. Integral Waterproofers: Added to concrete when installed within 5 feet of water features.
  - a. Acceptable Manufacturers:
    - 1) Hycrete W1000 by Hycrete.
- 8. Air Entrainers: Conforming to ASTM C 260, added to concrete to provide freeze-thaw resistance and provide additional workability of surface finish.
  - a. Acceptable Manufacturers:
    - 1) Daravair by Grace Construction Products.
    - 2) Micro-Air by Master Builders.
    - 3) Equal product by Euclid Chemical Company.

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9. Color Stains, Acid-Based: Low odor, low VOC, weather-resistant chemical-based reactive stains suitable for exterior concrete paving.
  - a. Acceptable Manufacturers:
    - 1) Lithochrome Chemstain Classic stains by Scofield.
    - 2) Classic Acid Stain by Classic Coating Systems.
    - 3) Blush-Tone Acid Stain stains by Brickform.
10. Color Stains, Water-Based: Water-based stains manufactured with polymeric emulsion and colorant suitable for exterior concrete paving.
  - a. Acceptable Manufacturers:
    - 1) Color Floor stains by Smith Paint Products.
    - 2) SmartColor stains by NewLook International.
    - 3) Water Base Stain by Classic Coating Systems.
- C. Joint Materials: Construction Joints:
  1. Dowel Baskets: Premanufactured dowel basket assembly to provide construction joint stability, eliminate tripping hazards, positive load transfer, maintain continuity of surface profile, reduce joint spalling, and reduce checkerboard pours without prohibiting horizontal slab movement.
    - a. Acceptable Manufacturers:
      - 1) PD3 Basket Assembly by PNA Construction Technologies.
      - 2) PNA Square/Round Dowel Basket Assembly by PNA Construction Technologies.
  2. Plastic Dowel Sleeves: Encase half length of each dowel in a Speed Dowel plastic alignment sleeve.
    - a. Acceptable Manufacturers:
      - 1) Speed Dowel by Greenstreak Group.
  3. Steel Slip Dowels: 5/8-inch-diameter smooth steel bars, free of dirt, grease, and oils.
  4. Isolation Joints: Refer to Section 079200 Joint Sealants.
- D. Curing Compounds:
  1. Liquid-Based: Liquid, membrane-forming, VOC compliant, resin-based dissipating type, and evaporation reducer compatible with concrete sealers that will not discolor concrete.
    - a. Acceptable Manufacturers:
      - 1) 1100-Clear by WR Meadows.
      - 2) Colorful Clear Curing Compound by Admixtures.
      - 3) Clear Cure by Anti-Hydro Company.
  2. Liquid-Based with Added Sealer: Water-based, non-yellowing acrylic, membrane-forming, VOC compliant compound with curing and sealing properties to facilitate in proper curing and hardening of freshly placed concrete and in sealing of concrete surface to improve resistance to chemicals, and minor abrasive damage.
    - a. Acceptable Manufacturers:
      - 1) Vocomp-20 by WR Meadows.
- E. Accessories:
  1. Concrete Slurry Release Compound: Tartatic-based compound spray or roller-applied to existing hardscape surfaces as a protection against concrete spatters and chemical overspray during concrete placement.
    - a. Acceptable Manufacturers:
      - 1) Pieri Face-Off products by Grace Construction.
      - 2) Kleen Kote by Progressive Solutions.

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2. Wood Form Release: Non-reactive, chemically inert wood form release.
  - a. Acceptable Manufacturers:
    - 1) Duogard II by WR Meadows.
3. Steel Dowel Anchor Adhesive: Two-component, non-shrink, epoxy-based adhesive.
  - a. Acceptable Manufacturers:
    - 1) Simpson Set22 by Simpson Strong Tie.
    - 2) Hit-HY 150 Max by Hilti.
4. Slip-Resistant Granules: Finely graded aggregate or polymer additive.
  - a. Acceptable Manufacturers:
    - 1) Skid Guard by Advanced Surfaces.
    - 2) Shur-Grip by Increte Systems.
    - 3) Grip Aid by Dayton Superior.
5. Curing Covers: Light traffic (LT), Medium Traffic (MT), or Heavy Traffic (HT).
  - a. Acceptable Manufacturers:
    - 1) CureMat by Skudo.
    - 2) UltraCure by PNA Technologies; [www.pna-inc.com](http://www.pna-inc.com).
6. Concrete Protection Covers: Durable, temporary covering system for the protection of freshly placed concrete during on-going construction activities:
  - a. Acceptable Manufacturers:
    - 1) Seekure 892 Finished Floor Protection Paper by Fortifiber.
    - 2) Orange Label Sisalcraft by Fortifiber.

### 2.07 CONCRETE MIXES

- A. General:
  1. Comply with ACI Manual of Concrete Practice PCA Engineering Bulletin - Design and Control of Concrete Mixtures.
  2. Proportion cement, fine aggregate, coarse aggregate, water, color pigment, and admixtures to attain required plasticity and strength in accordance with ACI 304R-00.
  3. Ensure that batch plant guarantees single source supply for cement, sand, and aggregate for the entire project.
  4. Mixing: Transit mix concrete produced in accordance with ASTM C 94.
    - a. If travel time exceeds limits, provide alternative means for mixing and submit for review and approval.
- B. Concrete Mix Criteria:
  1. Slump:
    - a. 5-inch, with a 1/2-inch slump differential between successive batches. Obtain approval from Architect if slump is outside these parameters.
  2. Compressive Strength:
    - a. 3,000 psi at 28 days.
  3. Quantity per cubic yard of concrete mix:
    - a. Minimum: 6 sack.
    - b. Maximum: 7 sack.
  4. Fly Ash:
    - a. Use only when using ASR-reactive aggregates.
    - b. Do not exceed 25% of total cement weight.
  5. Water/Cement (W/C) ratio:
    - a. Minimum: 0.50.

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- b. Maximum: 0.65.
- 6. Fine Aggregate:
  - a. No greater than 70% fine aggregate by ratio to coarse aggregate.
- 7. Coarse Aggregate:
  - a. Not less than 30% coarse aggregate by ratio to fine aggregate.
- 8. Admixtures:
  - a. Air entrainment: Do not exceed 2% by weight of cement.
  - b. Shrinkage Reducing: Do not exceed 2% by weight of cement.
- 9. Accelerators:
  - a. Use accelerators with caution.
  - b. Do not use calcium chloride.
- 10. Concrete Delivery:
  - a. Do not use concrete loads that exceed 90 minutes from time of batching to jobsite delivery.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Ensure that utilities, including irrigation lines are buried and compacted.
- B. Verify that waterproofing and drainage board are installed when pouring on structure.
- C. Confirm that utility locations including drain lines, electrical conduit, irrigation piping, and utility box lids have been reviewed and approved by Owner prior to placing concrete. Remedial work required to gain Owner approval to be borne by others.

#### 3.02 PREPARATION

- A. Surface Preparation:
  - 1. Subgrade: Four-inch layer sand compacted to 95 percent relative compaction.
  - 2. Moisten subgrade with an even spray prior to placing concrete to control initial loss of moisture from concrete slab. Do not place concrete over overly saturated subgrade.
  - 3. Grade to a tolerance of plus-or-minus 0.05-foot in 10 feet.

#### 3.03 INSTALLATION, INTECRETE

- A. Formwork:
  - 1. Design, engineer, and construct formwork necessary to install work.
  - 2. Formwork shall comply with ACI 347.
  - 3. Furnish formwork in largest practicable size to minimize joints and to conform to joint system as indicated on Contract Drawings.
  - 4. Coat forms with form-release agent prior to concrete placement to ensure separation from concrete without damage to concrete.
  - 5. Provide recesses and openings of proper sizes and shapes to accommodate required embeds. Secure anchor plates, inserts, and other items embedded in concrete by others.
- B. Reinforcement:
  - 1. Obtain Inspector's approval of reinforcing steel placement before placing concrete.
  - 2. Interrupt reinforcement at construction joints.
  - 3. Install fabricated bar mats in lengths as long as practicable.
  - 4. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain specified concrete cover over reinforcement.

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### C. Concrete Placement:

1. Obtain Architect approval of formwork prior to placing concrete.
2. Prior to placing concrete, apply Concrete Slurry Release Compound or plastic sheeting to adjacent hardscape surfaces for protection against concrete spatters and chemical overspray during concrete placement.
3. Deliver and discharge concrete from truck within 90 minutes hours after introduction of water or within 300 revolutions of drum.
4. Place concrete in conformance to ACI 304R-00.
5. Do not add water to concrete during delivery or placement, however, to obtain specified slump, additional water may be added to concrete before placement provided that amount of water will not exceed total amount of water allowed as stated on delivery ticket.
6. Place concrete no faster than it can be properly placed and finished with due regard to weather, temperature size and abilities of finishing crew.
7. Place concrete in a continuous operation between pre-located construction joints.
8. Prior to accumulation of bleed water, bull float or darby to level and smooth concrete surface.
9. After bleed water has evaporated, tool required joints and edges and hand float and finish as required.
10. Hot Weather Concrete Placement (90 Degrees F and Hotter). Refer to ACI 305R:
  - a. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F.
- \*11. Cold Weather Concrete Placement (40 Degrees F and Colder). Refer to ACI 306R-10:
  - a. Uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of concrete placement.
  - b. Do not place concrete when ambient temperature is 35 degrees F or lower or is expected to go below that temperature within 24 hours of placement.

### D. Jointing:

1. Construct contraction, construction, and isolation joints in paving with tooled edges true to line with faces perpendicular to surface plane of concrete paving. Construct joints on uniform centers.
2. Refer to ACI 302.1R-04 for paving joint design.
3. Unless approved in writing by Architect, do not exceed a joint spacing of 12-feet on centers in each direction for a 4-inch thick slab or 16-feet on center in each direction for a 6-inch slab.
4. Construct contraction and construction joints straight and true to a tolerance not to exceed 3/16-inch in 10-feet.
5. Contraction Joints: Hand-tooled contraction joints:
  - a. Place contraction joints in fresh concrete by grooving and finishing each joint edge by hand with a radiused jointer tool.
  - b. Do not exceed 3/16-inch in joint width unless approved in writing by Owner.
  - c. Install joints in a straight line with no over-tooling at joint intersections. Tool joints to specified width and depth.
6. Saw Cut Contraction Joints:
  - a. Provide sawcut contraction joints as soon as concrete has sufficient strength to support sawing equipment and reduce joint edge and aggregate spalling. Sawcut slab no more than 12 hours after slab placement, prior to developing unsightly random slab cracking, but before spalling occurs.

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- b. Carefully check condition of concrete before commencing saw-cutting operations to ensure that concrete blade will not spall edges of saw cuts or dislodge aggregate.
      - c. Do not exceed 3/16-inch in joint width unless approved in writing by Owner.
    - 7. Construction Joints:
      - a. Install construction joints where contiguous paving operations have stopped for more than 90 minutes, adjacent different paving types abut, end of day pour, or other delays in placing additional concrete.
      - b. Discontinue steel reinforcement across construction joints.
      - c. Install construction joints as follows:
        - 1) Dowel Baskets:
          - a) Install steel dowel baskets in order to provide joint stability, positive load transfer, maintain continuity of surface profile, reduce joint spalling, and reduce the amount of "checkerboard" pours.
          - b) Ensure that steel dowel baskets are spaced no greater than 25-foot o.c.e.w. for 4-inch slabs and 40-feet o.c.e.w. for 6" slabs unless approved by Architect.
        - 2) Steel Dowels:
          - a) Provide steel dowels across construction joints to reduce differential movement across joint. Utilize steel dowels as follows:
            - (1) 4-inch thick paving: 3/8-inch diameter by 12-inch minimum length.
            - (2) 6-inch thick paving: 1/2-inch diameter by 12-inch minimum length.
        - 3) To assist in correct alignment of steel dowels along construction joints use plastic dowel alignment sleeves, or approved equal:
          - a) Ensure that wood edge forms are true to line and grade prior to installing plastic dowel alignment sleeves.
          - b) Install plastic dowel sleeves on wood forms at the specified on-center dowel spacing, centered between top and bottom of wood form.
  - 8. Isolation Joints:
    - a. Refer to Section 079200 Joint Sealants for specific caulking requirements.
    - b. Install isolation joints when horizontal paving abuts fixed vertical elements such as walls, buildings, steps, columns, vaults, or other vertical obstructions. If Drawings do not require isolation joints in these situations, contact Owner for direction prior to placing concrete.
- E. Curing:
- 1. Cure concrete immediately after exposing aggregates.
  - 2. Do not allow concrete surface to alternate between wet and dry during curing period.
  - 3. Cure concrete per ACI 308.1-98 per one of following methods that will not mottle, discolor, or stain concrete surface being cured:
    - a. Liquid Curing Compounds:
      - 1) Apply uniformly in continuous operation by spray or roller according to manufacturer's directions.
      - 2) Recoat areas subjected to heavy rainfall within 3 hours after initial application.
    - b. Curing Blankets:
      - 1) Water saturate curing blankets and keep continuously wet. Lap joints and seal with water-resistant pressure-sensitive tape.
      - 2) Seal perimeter edges and penetrations with 12-inch laps.
      - 3) Ensure that curing blankets are kept flat on concrete surface.
      - 4) Maintain curing blankets for a minimum of 7 days.

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- F. Final Washing
  - 1. Prior to final Architect site review for acceptance, or no later than 28 days after initial concrete placement, power wash surface of paving with a modified muriatic acid cleaning solution.
- G. Final Sealing
  - 1. Seal concrete paving with one of three specified proprietary concrete sealers.
  - 2. Follow sealer manufacturer's directions for sealer application.
  - 3. Allow surface of paving to dry sufficiently before applying final sealer.
  - 4. Do not apply sealer if air temperatures are below 50 degree F and above 90 degrees F.
  - 5. Once the concrete surface has been sealed, protect from pedestrian and vehicular traffic until product has sufficiently dried.

### 3.04 INSTALLATION, LITHOCRETE

- A. Forms: Comply with requirements of Section 321313.
  - 1. Ensure that form lumber is new No. 2 or better grade wood. Use new form lumber.
  - 2. Do not exceed 15-foot by 15-foot in a formed construction area unless dowel baskets are used.
- B. Concrete Conveying and Placement: Convey and place concrete in accordance with ACI 301 and as specified in Section 321313. Place continuously between predetermined construction joints.
  - 1. Installation: ACI 302 Guide for Concrete Floor and Slab Construction.
  - 2. Consolidation: Comply with ACI 304R.
  - 3. Troweling: ACI 301, two-step trowel finish.
  - 4. Hot Weather Placement: Comply with ACI 305R.
- C. Joints and Decorative Scoring: Immediately after slab has achieved initial set, saw cut 3/16-inch wide contraction joints and decorative scoring to one-third of slab depth using new diamond-tipped circular saw blade. Locate joints to create panels and patterns indicated on the Contract Drawings.
  - 1. Edges: Rounded, 1/8-inch radius unless otherwise indicated.
  - 2. Do not tool joints or use embedded joint material.
  - 3. Joint Width: In accordance with Contract Drawings. Do not exceed 3/16-inch in width.
  - 4. Depth of Saw Cuts: 1/4th depth of slab.
  - 5. Decorative Sawcut Joints: In accordance with Contract Drawings.
  - 6. Saw cut joints in a straight line with no over-cutting.
  - 7. Use a hand tool to sawcut up to vertical edges such as walls, steps, curbs and columns. No cutting into vertical surfaces will be allowed.
- D. Isolation Joint Caulking:
  - 1. Install isolation joint caulking to be installed in accordance with the requirements of Section 079200.
- E. Hand-Seeded Aggregate: Trowel finish concrete surface with two-step process. Comply with integral color admixture supplier's published proprietary procedures using suitable tools and solutions.
  - 1. When required, apply set retarder in accordance with supplier's instructions and recommendations to compensate for sun exposure, ambient air temperature, and humidity to produce a finish that has a consistent appearance throughout Project.
  - 2. Avoid overspray of set retarder onto adjacent areas.
  - 3. After concrete has set, wash surface in accordance with proprietary procedures to expose aggregate.

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- F. Etching: Comply with instructions and recommendations of integral color admixture manufacturer, applicable industrial safety regulations, and environmental protection statutes for use of acidic etching solutions, including clean up procedures.
  - 1. Perform etching procedure in three phases:
    - a. First Washing: Within 3 days of concrete placement. Upon completion, resume curing procedures.
    - b. Second Washing: Approximately 21 days after first washing.
    - c. Third Washing: After completion of surrounding construction activities and in Preparation for Substantial Completion review.
  - 2. Provide containment measures for acidic wash solution to prevent contamination of surrounding areas.
  - 3. Use suitable containers and tools in compliance with instructions and recommendations of integral color admixture manufacturer.
  - 4. Surface shall have minimum static coefficient of friction of 1.3 to 1.6 (dry) and 1.2 to 1.4 (wet) when field tested in accordance with ASTM C 1028.
- G. Curing: After initial surface exposure, begin curing procedures. Comply with integral color admixture manufacturer's instructions and recommendations. Continue moist curing for minimum of 7 days without foot traffic and thirty (30) days without vehicular traffic.
  - 1. Cure using moisture-retaining (sheet) method, or, at Contractor's option, maintain moisture at concrete surface with fog-spray.
  - 2. Curing procedure shall not discolor, cause loss of adhesion of exposed aggregate, or otherwise cause detrimental appearance to integrally colored concrete surface.
  - 3. If a curing compound is required, use specified curing compound.
- H. Sealing: Seal surface of paving with 3 to 6 coats of specified sealer. Follow sealer manufacturer directions.

### 3.05 TOLERANCES

- A. Paving Tolerances:
  - 1. Comply with paving tolerances contained in ACI 117 as follows:
    - a. Elevation: 1/4-inch.
    - b. Thickness: Plus 3/8-inch, minus 1/4-inch.
    - c. Surface: Gap below 10-foot long unlevelled straightedge not to exceed 1/4-inch.
    - d. Lateral Alignment of Dowels: 1-inch.
    - e. Vertical Alignment of Dowels: 1/4-inch.
    - f. Alignment of Dowel Bar Ends Relative to Line Perpendicular to Paving Edge: Length of steel dowel 1/4-inch per 12-inches.
    - g. Joint Spacing: 3-inches.
    - h. Contraction Joint Depth: Minimum 1/4 x depth of slab.
    - i. Joint Width: Refer to Contract Drawings, but in no case exceed 3/16-inch.

### 3.06 ADJUSTING

- A. Remove and replace concrete that is broken, damaged, or does not comply with requirements in this Section in completed sections from joint to joint, unless approved by Owner.

### 3.07 CLEANING

- A. Follow supplier's recommended procedures for cleaning and care. Keep Work area clean, neat and orderly throughout duration of project.

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- B. Surfaces exposed to salts, chlorine, and chemicals shall be washed immediately with potable water and pressure washed at the first sign of calcification or salt build up and resealed with specified sealer and a waterproofing sealer.
- C. Prior to Final Acceptance by Owner, clean up and remove deleterious materials and debris from work area.

### **3.08 CLOSEOUT ACTIVITIES**

- A. Provide copy of Paving Operations and Maintenance Manual and review proper long term maintenance with Owner's maintenance personnel for.

**END OF SECTION**

**Exposed Aggregate Concrete Paving - 321314**

**SECTION 321273 – CONCRETE PAVING JOINT SEALANTS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. The General Conditions and Division - 1 Specification sections apply to the work of this section.
- B. The following documents form part of the Specifications to the extent stated. Where differences exist between Codes, Standards, Authorities Having Jurisdiction, and the Documents, the one affording the greatest protection and/or more stringent condition shall apply.
- D. This Section includes the following:
  - 1. Expansion joints, contraction joints, isolation joints, and construction joints within exterior concrete pavement.

**1.02 REFERENCES**

- A. ASTM International (ASTM):
  - 1. C1087 - Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
  - 2. C1193 - Guide for Use of Joint Sealants.
  - 3. D5249 - Standard Specification for Backer Material for Use with Cold- and Hot- Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints.
  - 4. D5893 - Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

**1.03 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For each type and color of joint sealant required.
- C. Product certificates.
- D. Compatibility and Adhesion Test Reports: From sealant manufacturer.

**1.04 QUALITY ASSURANCE**

- A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
- B. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- C. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

**1.05 WARRANTY**

- A. Warranty Period: One year from date of Substantial Completion.

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**1.06 EXTRA MATERIALS**

- A. Furnish two units of extra joint sealant of each type and color provided.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- 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.

**2.02 MATERIALS, GENERAL**

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
  - 1. Primers: Product 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. Colors of Exposed Joint Sealants: As selected by Landscape Architect from manufacturer's full range.
  - 1. Provide custom colors for Decorative Concrete Paving.

**2.03 COLD-APPLIED JOINT SEALANTS**

- A. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D5893 for Type SL.
  - 1. Products:
    - a. DynaTred from Pecora Corporation for exterior paving.
    - b. Crafcro Inc.; RoadSaver Silicone SL.
    - c. Dow Corning Corporation; 890-SL.
    - d. Or approved equal.

**2.04 JOINT-SEALANT BACKER MATERIALS**

- A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Sealants: ASTM D5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

**PART 3 - EXECUTION**

**3.01 EXAMINATION**

- A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

**3.02 INSTALLATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

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- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience.
- C. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- D. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- E. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
- G. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
- H. Protect sealants from dirt and debris until they have had sufficient time to cure.
- I. Provide a final cleaning of all exposed joint sealants at time of Substantial Completion.

**END OF SECTION**

**Concrete Paving Joint Sealants– 321273**

**SECTION 323219 – UNIT MASONRY RETAINING WALL**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Concrete unit masonry assemblies consisting of a reinforced concrete footing and a reinforced concrete masonry unit stem.
- B. Referenced Sections:
  - 1. Section 012500 - Substitution Procedures.
  - 2. Section 013300 - Submittal Procedures.
  - 3. Section 014500 - Quality Control.
  - 4. Section 017419 - Construction Waste Management and Disposal.
  - 5. Section 018113 - Sustainable Design Requirements.
  - 6. Section 032100 - Reinforcing Steel: General requirements of reinforcing steel.

**1.02 DEFINITIONS**

- A. *Reinforced Masonry*: Masonry containing reinforcing steel in grouted cells.
- B. CMU(s): Concrete masonry unit(s).

**1.03 REFERENCED STANDARDS**

- A. ASTM International (ASTM):
  - 1. C 90 - Specification for Loadbearing Concrete Masonry Units.
  - 2. C 150 - Specification for Portland Cement.
  - 3. C 207 - Specification for Hydrated Lime for Masonry Purposes.
  - 4. C 404 - Specification for Aggregates for Masonry Grout.
  - 5. C 476 - Specification for Grout for Masonry.
  - 6. C 1019 - Test Method of Sampling and Testing Grout.
  - 7. C 1148 - Test Method for Measuring the Drying Shrinkage of Masonry Mortar.
  - 8. C 1314 - Test Method for Compressive Strength of Masonry Prisms.
  - 9. C 1357 - Test Methods for Evaluating Masonry Bond Strength.
  - 10. E 514 - Test Method for Water Penetration and Leakage Through Masonry.
- B. California Code of Regulations (CCR):
  - 1. Title 24, Part 2- California Building Code (CBC), 2019 edition:
    - a. Chapter 17 - Structural Tests and Special Inspections.
    - b. Chapter 21 - Masonry.
      - 1) Section 2103 - Masonry Construction Materials.
        - a) Section 2103.1 - Concrete Masonry Units.
      - 2) Section 2105 -Quality Assurance.
        - a) Section 2105.1 - General.
      - 3) Section 2114 - Additional Requirements.
  - 2. Title 24, Part 11 - California Green Building Standards Code (CALGreen Code) (CGC), 2019 edition.
- C. American Concrete Institute (ACI):
  - 1. ACI Manual of Concrete Practice, latest edition.
    - a. 318 - Building Code Requirements for Reinforced Concrete.

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- D. The Masonry Society/American Concrete Institute/Structural Engineering Institute of the American Society of Civil Engineers (TMS)/(ACI)/ (SEI/ ASCE/ERTA):
  - 1. TMS 402/ACI 530/530.1/ASCE 6-13/ERTA - Building Code Requirements and Specification for Masonry Structures and Companion Commentaries.

### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.
- \*B. Coordination: Refer to Section 018113 regarding procedures for implementing sustainable design requirements.
- C. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

### 1.05 SUBMITTALS

- A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.
- B. Shop Drawings: Show fabrication and installation details for the following:
  - 1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
  - 2. Masonry Units: Show sizes, profiles, coursing and locations of special shapes.
- C. Samples:
  - 1. Integrally colored unit masonry samples in small-scale form showing the full range of colors and textures for each different exposed masonry unit required.
  - 2. Colored mortar samples.
  - 3. Exposed or decorative CMUs.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
  - 1. Each type of masonry unit required.
  - 2. Grout mixes complying with compressive strength requirements of ASTM C 476. Include description of type and proportions of grout ingredients.
- E. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
  - 1. Each type of masonry unit required.
  - 2. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
  - 3. Each material and grade indicated for reinforcing bars.
- F. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
  - 1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

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- G. Material Certificates: For each type and size of the following:
  - 1. Masonry units.
    - a. Include data on material properties.
  - 2. Cementitious materials. Include brand, type and name of manufacturer.
  - 3. Grout mixes. Include description of type and proportions of ingredients.
  - 4. Reinforcing bars.
- H. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
  - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength.
  - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- I. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- J. Hot Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

### 1.06 SUSTAINABLE DESIGN SUBMITTALS

- A. Materials & Resources Submittals: Refer to Section 018113 for additional information on LEED submittals.
  - 1. Letter Template for MR Credit 2: Letter template, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
    - a. Comply with Section 017419 Construction Waste Management and Disposal.
  - 2. Product Data and Certification Letter for MR Credit 4: Indicate percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
  - 3. Product Data for MR Credit 5: For regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

### 1.07 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
- D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

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- E. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing as required by 2013 CBC Section 2105 and indicated below. Where full allowable design stresses are used, prism testing shall be carried out during construction per Section 2105.3. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
  - 1. Concrete Masonry Units: Shall be of sizes shown on drawings and conform to ASTM C 90 (CBC 2103.1).
  - 2. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
  - 3. Mortar Test (Property Specification): For each mix required, according to ASTM C 109 for compressive strength.
  - 4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.
  - 5. Prism Test: For each type of construction required, according to ASTM C 1314.
- F. Sample Panels: Before installing unit masonry, build sample panels, using materials indicated for the completed Work, to verify selections made under sample Submittals and to demonstrate aesthetic effects. Build sample panels for each type of exposed unit masonry assembly in sizes approximately 48 inches long by 48 inches high by full thickness.
  - 1. Locate panels in the locations indicated or, if not indicated, as directed by Architect.
  - 2. Clean exposed faces of panels with masonry cleaner indicated.
  - 3. Delete subparagraph below if not applicable.
  - 4. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
  - 5. Maintain sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
  - 6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
    - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels, unless such deviations are specifically approved by Architect in writing.
  - 7. Demolish and remove sample panels when directed.

### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
  - 1. Protect Type I concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

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### 1.09 FIELD CONDITIONS

- A. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602/ERTA and ACI 531R Commentary Part 3 Chapter 5 regarding hot weather requirements for mortar and grout. Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
  - 1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.
- B. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  - 1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
  - 1. Angeles Block Company, Orange, CA (714)637-8594.
  - 2. Orco Block Company, Stanton, CA (714)527-2239.
  - 3. RCP Block & Brick, Santee, CA (800)794-4727, [www.rcpblock.com](http://www.rcpblock.com).
- B. Design is based on the use of accessory products manufactured by the following, or equal:
  - 1. BASF (Master Builders Solutions), Cleveland, OH with regional resource center at (800)627-2929, (800)233-1232, <http://www.master-builders-solutions.basf.us/en-us>.
  - 2. Grace Construction Products, Cambridge, MA (617)876-1400, (800)558-7066.
  - 3. Kel-Crete Industries, Tulsa, OK (918)622-4530, (800)845-1833, represented by Omega Products, (714)556-3830.
  - 4. Master Builders Technologies, division of Degussa, Cleveland, OH (216)831-5500, (800)228-3318, (714)476-0500 [Admixtures], (800)824-8441 [Construction Products].
  - 5. ProSoCo, Inc., Kansas City, KS (913)281-2700, with representation in San Clemente, CA (949)498-7077, [www.prosoco.com](http://www.prosoco.com).
  - 6. Sika Corporation, Lyndhurst, NJ (800)933-7452, [www.sikacorp.com](http://www.sikacorp.com).
- C. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of other manufacturers accepted in advance in accordance with Section 012500.

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## **2.02 REGULATORY REQUIREMENTS**

- A. Regulations:
  - 1. Materials, construction, and workmanship shall be in accordance with CBC Section 2105A.
  - 2. Comply with requirements of ACI 216, including NCMA TEK 7-1A regarding the calculation of fire resistance ratings for concrete masonry assemblies.
  - 3. Comply with ASTM C 1314, the replacement for ASTM E 447, if accepted by the building official.
- B. Waste Management: Comply with CALGreen Section 5.408 Construction Waste Reduction, Disposal and Recycling. Establish a construction waste management plan for the diverted material.
  - 1. Recycle or salvage for reuse a minimum of 65 percent of the non-hazardous construction and demolition waste in accordance with CALGreen 5.408.1.3.

## **2.03 PERFORMANCE REQUIREMENTS**

- A. Provide structural unit masonry that develops net-area compressive strengths at 28 days as indicated on Contract Drawings.
  - 1. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

## **2.04 CONCRETE MASONRY UNITS**

- A. General: Provide shapes indicated and as follows:
  - 1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
  - 2. Provide bullnose units for outside corners, unless otherwise indicated.
  - 3. Delete subparagraph above or below.
  - 4. Provide square-edged units for outside corners, unless indicated as bullnose.
  - 5. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. CMUs: ASTM C 90 and as follows:
  - 1. Unit Strength: Minimum individual unit strength as indicated on drawings;  $F'_m = 1,500$  psi grouted solid reinforced cells.
  - 2. Density Classification: Medium weight.
  - 3. Provide Type I, moisture-controlled units.
  - 4. Size (Width): Manufactured to the dimensions  $3/8$  inch less than nominal dimensions.
  - 5. Exposed Faces: Uniform color and size, manufacturer's standard color and texture, unless otherwise indicated.
  - 6. Shrinkage: Maximum linear shrinkage is 0.06%.
  - 7. Joints: All head and bed joints shall be  $3/8$ " thick. Bed joints of the starting course over the concrete foundation may be between  $1/4$ " and  $3/4$ " (ACI 530.1-05, Section 3.38.)

## **2.05 MORTAR AND GROUT MATERIALS**

- A. Portland Cement: ASTM C 150, Type I or II; or Portland Cement for grout and mortar shall conform to Section 201, Concrete Mortar and Related Materials, of the Standard Specifications (the Greenbook). Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, type S.

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- C. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve or conform to Section 201-1.2.2 Aggregates of the Greenbook.
- D. Aggregate for Grout: ASTM C 404; at least 20% of the aggregate shall be course aggregate. The Contractor shall determine the grading except that between 90%-100% of the combined grading shall pass the 1/2-inch sieve.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in mortar.
- F. Water: Potable.
- G. Mortar Sand: Shall be commercial quality.
- H. Caulking: for sealing expansion joints, shall be a non-sag polysulfide or polyurethane material conforming to the provisions in Federal Specification TT-S-230, Type II
- I. Mortar for laying masonry units shall consist, by volume, of one part portland cement, 0 to 1/2 parts of hydrated lime, and 2-1/4 to 3 parts of mortar sand. Sufficient water shall be added to make a workable mortar. Each batch of mortar shall be accurately measured and thoroughly mixed. Mortar shall be freshly mixed as required. Mortar shall not be retempered more than one hour after mixing.
- J. At the option of the Contractor, grout for filling masonry units may be proportioned either by volume or weight. Grout shall contain only enough water to cause it to flow and fill the voids without segregation. The maximum amount of free water shall not exceed 0.7 times the weight of the cement. Grout proportioned by volume shall consist of at least one part portland cement and 4.5 parts aggregate. Aggregate volumes shall be based on a loose, air-dry condition. Grout proportioned by weight shall contain at least 564 pounds of portland cement per cubic yard.

### 2.06 REINFORCING STEEL

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M (CBC 2103.13.1), Grade 60.
- B. Bars shall be clean of loose flaky rust, grease or other materials likely to impair bond (ACI 318, Section 5.7).

### 2.07 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors, specified in subsequent articles, made from materials that comply with this Article, unless otherwise indicated.
- B. When one continuous bar cannot be used, a lap or splice of 40-bar diameters is required.
- C. Hot-Dip Galvanized Carbon-Steel Wire: ASTM A 82/A82M; with ASTM A 153/A153M, Class B-2 coating.
- D. Steel Sheet, Galvanized after Fabrication: ASTM A 366/A 366M cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153.
- E. Steel Plates, Shapes, and Bars: ASTM A 36.
- F. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563/A563M hex nuts and where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

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- G. Postinstalled Anchors: Torque-controlled expansions anchors or chemical anchors.
  - 1. Load Capacity: as indicated on construction drawings.
  - 2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633
  - 3. Material of Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

### 2.08 CONCRETE FOOTINGS

- A. Refer to Section 031000, Section 032000, and Section 033100 for the concrete footing specifications necessary to support the CMU retaining walls.

### 2.09 MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- C. Preformed Control-Joint Gaskets: Made from PVC, complying with ASTM D 2287, type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall. Size and configuration as indicated.
- D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Form units from 0.148-inch steel wire.
  - 1. Provide units with loops as needed for number of bars indicated.

### 2.10 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetra-sodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.

### 2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
  - 1. Provide minimum 28 day compressive strength equal to 2,000 psi.
  - 2. Do not use calcium chloride in mortar or grout.
  - 3. Use Portland cement-lime mortar unless otherwise indicated.
  - 4. Grout shall conform to Table 2103.12 or to ASTM C 476.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification.
  - 1. Limit cementitious materials in mortar to Portland cement and lime.
  - 2. For all reinforced masonry, use Type S.
  - 3. Mortar unused after 1-1/2 hours from initial mix time shall not be used.
  - 4. The mortar mix must have a compressive strength equal to 2,000 psi minimum (CBC Table 2105.2.2.1.2). Mortar for use in masonry construction shall conform to ASTM C 270 and shall conform to the proportion specifications of Table 2103.8(1) or the property specifications of Table 2103.8(2) of the CBC.
- C. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Limit pigments to the following percentages of cement content by weight:
  - 1. For mineral-oxide pigments and portland cement-lime mortar, not more than 10 percent.
  - 2. For carbon-black pigment and portland cement-lime mortar, not more than 2 percent.

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3. Mix to match Architect's sample.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
  1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/ TMS 602 for dimensions of grout spaces and pour height.
  2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.
  3. Grout shall be transit mixed, and shall not be used if more than 1-1/2 hours have elapsed since water was added.
  4. Grout shall be specified by proportion requirements or property requirements.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
  1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
  2. Verify that foundations are within tolerances specified.
  3. Verify that reinforcing dowels are properly placed.
  4. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.
- C. Continuous inspection of masonry construction shall be provided by the Owner's testing agency. Refer to Section 014500 for testing and inspection requirements.
  1. Additional testing is required when full allowable stresses are used in design.

#### 3.02 INSTALLATION, GENERAL

- A. Thickness: Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
- D. Use full size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
  1. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

#### 3.03 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets.

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Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

- B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
  - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
- C. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- F. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.

### 3.04 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in all courses of piers, columns and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.
  - 1. For glazed masonry units, use a nonmetallic jointer 3/4 inch or more in width.
- C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

### 3.05 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joints in unit masonry where indicated. Build-in related items as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
  - 1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.

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### **3.06 LINTELS**

- A. Provide masonry lintels where shown and where openings of more than 24 inches for block-size units are shown without structural steel or other supporting lintels.
  - 1. Provide built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

### **3.07 REINFORCED UNIT MASONRY INSTALLATION**

- A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
  - 1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6.
  - 1. Reinforcement in concrete shall be protected from corrosion and exposure to chlorides (ACI 318-05, Section 7.7.6). Concrete protection for reinforcement shall be at least 3" to earth when the concrete is poured against the earth (ACI 318-05, Section 7.7.1).
  - 2. One #4 reinforcing bar must be placed longitudinally within the wall in a bond beam block every 16 inches as the blocks are laid up.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
  - 1. Comply with requirements of ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  - 2. Low-Lift Grouting:
    - a. Use Low-Lift grouting technique with "Fine Grout" per ASTM C 476 for the following:
      - 1) Walls with grout space of 4" or less in width.
    - b. Construct low-lift masonry by placing reinforcement, laying masonry units and pouring grout as the work progresses.
    - c. Place vertical reinforcement bars and supports prior to laying of masonry units. Horizontal reinforcement bars may be placed progressively with laying of masonry units.
    - d. Limit grout pours as required to prevent displacement of masonry by grout pressures (blowout), but do not exceed 24" pour height.
    - e. Pour grout using container with spout and consolidate immediately by rodding or puddling; do not use trowels. Place grout continuously; do not interrupt pouring of grout for more than one hour. If poured in lifts, place from center-to-center of masonry courses. Terminate pour 1-1/2" below top of highest course in pour.
  - 3. High-Lift Grouting:
    - a. High-lift grouting technique may be used for the following masonry construction:
      - 1) Walls with grout spaces of 4" or greater width.
    - b. Place reinforcement and support in proper position, prior to laying of masonry units.
    - c. Construct high-lift masonry by laying masonry to full height and width prior to placing of grout. Provide cleanout holes in first course of masonry, and use high-pressure water jet stream to remove excess mortar from grout spaces, reinforcement bars and top surface of

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structural members which support wall. Clean grout spaces daily during construction of masonry.

- d. Preparation of Grout Spaces: Prior to grouting, inspect and clean grout spaces. Remove dirt, dust, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper positioning. Clean top surface of structural members supporting masonry to ensure bond. After cleaning and inspection, close cleanout holes with matching masonry units and brace closures to resist grout pressures.
- e. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure, but not less than 3 days curing time. Install shores and bracing, if required, before starting grouting operations.
- f. Place grout by pumping into grout spaces.
- g. Use coarse grout per ASTM C 476. Rod or vibrate each grout lift during placing and again after excess moisture has been absorbed, but before plasticity is lost. Do not penetrate or damage grout placed in previous lifts or pours.
- h. Limit grout pours to sections which can be completed in one working day with not more than one hour interruption of pouring operation. Limit pours so as not to exceed the capacity of masonry to resist displacement or loss of mortar bond due to grout pressures.
- i. Where pour height exceeds 4', place grout in a series of lifts not exceeding 4' height. Place each lift as a continuous pouring operation. Allow not less than 30 minutes, nor more than one hour between lifts of a given pour.

### **3.08 WALL DRAINAGE**

- A. Refer to geotechnical report prepared by Geocon, Inc. for retaining wall subdrainage recommendations and details.
  1. Refer to Section 334600 for subdrainage specifications.
- B. Perforated pipe should outlet through a solid pipe to a free gravity outfall or directly into an adjacent underground storm drain that is at an elevation to accept the pipe outlet. Perforated pipe and outlet pipe should have a fall of at least 1 %.
- C. As an alternative to the perforated pipe and outlet, weep-holes may be constructed. Weep-holes shall be at least 2 inches in diameter, spaced no greater than 8 feet, and be located just above grade at the bottom of wall.
- D. Filter fabric should consist of Mirafi 140N, Supac 5NP, Amoco 4599, or similar approved fabric. Filter fabric should be overlapped at least 6-inches.
- E. Geocomposite panel drain should consist of Miradrain 6000, J-DRain 400, Supac DS-15, or approved similar product.

### **3.09 WATERPROOFING**

- A. Contractor to supply and install a cementitious crystalline waterproofing to CMU retaining wall, above-grade and below-grade, behind the CMU units.
- B. Refer to geotechnical report prepared by Geocon for additional damp-proofing or water-proofing recommendations and details.

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### C. Products:

1. 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:
  - a. Xypex Concentrate
  - b. Xypex Modified
  - c. Xypex Patch n' Plug

### D. Mixes:

1. General: Mix waterproofing material by volume with clean water which is free from salt and deleterious materials. Mix waterproofing material in quantities that can be applied within 20 to 30 minutes from time of mixing. As mixture thickens, stir frequently, but do not add additional water. Do not mix bonding agents or admixtures with crystalline waterproofing materials.
2. Brush Application Mix: Measure dry powder and place in mixing container. Measure water and mix into the dry powder with a paddle on a slow speed electric drill (250 RPM) or other type mixer which is acceptable to manufacturer. Mixing proportions shall be as follows:

Coverage	Proportions (by Volume)
1.5 lb./sq. yd.	5 powder to 2 water
2.0 lb./sq. yd.	3 powder to 1 water
3. Spray Application Mix: Mixing shall be same as specified for brush application except that mixture shall be thinner. Use following proportions as a guide only. Adjust proportions to match type of spray equipment and pressures used. Mixing proportions shall be as follows:

Coverage	Proportions (by Volume)
1.5 lb./sq. yd.	5 powder to 3 water
4. Dry-Pac Mix: Using a trowel, mix 1 part clean water with 6 parts Xypex Concentrate powder for 10 to 15 seconds. It is acceptable that lumps may be present in mixture.
  - a. Mix only as much as can be applied in 15 minutes.

### E. Examination:

1. Site Visit: Prior to waterproofing installation, arrange visit to project site with waterproofing manufacturer's representative. Representative shall inspect and certify that concrete surfaces are in acceptable condition to receive waterproofing treatment.
2. Verification of Substrates: Verify that concrete surfaces are sound and clean, and that form release agents and materials used to cure the concrete are compatible with waterproofing treatment.
3. Examination for Defects: Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects to be repaired in accordance to manufacturer's product data.

### F. Preparation:

1. Concrete Finish: Concrete surfaces to receive waterproofing treatment shall have an open capillary system to provide tooth and suction, and shall be free from scale, excess form oil, laitance, curing compounds and foreign matter. Horizontal surfaces shall have a rough wood float or broom finish. Where a smooth trowel finish is shall be applied by dry shake method at time of concrete finishing in accordance with manufacturer's product data.
2. Surface Preparation: Smooth surfaces (e.g. where steel forms are used) or surfaces covered with excess form oil or other contaminants shall be washed, lightly sand-blasted, water-blasted, or acid etched with muriatic acid as necessary to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.

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3. Repair of Defects: Surface defects shall be repaired in accordance with manufacturer's instructions as follows:
  - a. Form Tie Holes, Construction Joints, Cracks: Chip out defective areas in a "U" shaped slot one inch (25 mm) wide and a minimum of one inch (25 mm) deep. Clean slot of debris and dust. Soak area with water and remove excess surface water. Apply a slurry coat of Xypex Concentrate at the rate of 1.5 lb./sq. yd. (0.8 kg/m<sup>2</sup>) to the slot. Allow slurry to reach an initial set, then fill cavity with Dry-Pac.
  - b. Compress tightly into cavity using pneumatic packer or block and hammer.
  - c. Rock Pockets, Honeycombing or Other Defective Concrete: Rout out defective areas to sound concrete. Remove loose materials and saturate with water. Remove excess surface water and apply a slurry coat of Xypex Concentrate to area. After slurry has set, but while still "green", fill cavity to surface level with:
    - 1) non-shrink grout.
4. Wetting Concrete: Prior to application of waterproofing treatment, thoroughly saturate concrete surfaces with clean water as required to ensure migration of crystalline chemicals into voids and capillary tracts of the concrete. Remove free surface water before application.

**G. Application:**

1. Construction Joints: Apply Xypex Concentrate in slurry form at a rate of 2.0 lb./sq. yd. (1.08 kg/m<sup>2</sup>) to joint surfaces between concrete pours. Moisten surfaces prior to slurry application. Where joint surfaces are not accessible prior to pouring new concrete, consult manufacturer for application procedure.
2. Sealing Strips and Coves: Prepare concrete surfaces that will come into contact with sealing strips and coves by applying one coat of Xypex Concentrate in slurry form at a rate of 1.5 lb./sq. yd. (0.8 kg/m<sup>2</sup>). Then apply Xypex Concentrate in Dry-Pac form (sealing strip) or Xypex Modified in mortar consistency (cove) after slurry coat has reached an initial set but is still "green".
  - a. Sealing Strips: Where indicated on drawings, fill preformed grooves, one inch (25 mm) wide and minimum of 1.5 inch (37 mm) deep, located at construction joints with Xypex Concentrate in Dry-Pac form. Compact Dry-Pac tightly into groove using a pneumatic packer or hammer and block.
  - b. Coves: Where indicated on drawings, trowel apply and pack Xypex Modified mortar into a cove shape.
3. Surface Application: After repairs, surface preparation, treatment of construction joints and sealing strip placement have been completed in accordance with manufacturer's product data and as specified herein, apply Xypex treatment uniformly to concrete surfaces with semi-stiff bristle brush or broom, or suitable spray equipment. Application rates and locations shall be as indicated in the drawings and in accordance with manufacturer's product data. When brushing, work slurry well into surface of the concrete, filling surface pores and hairline cracks. When spraying, hold nozzle close enough to ensure that slurry is forced into pores and hairline cracks.
  - a. First Coat (of one or two coat application): Apply Xypex Concentrate slurry coat to locations indicated on drawings in accordance with manufacturer's product data.
4. Second Coat (of two coat application): Where indicated on drawings or as required by manufacturer's product data, apply Xypex Modified slurry coat while first coat of Xypex Concentrate is still "green" but after it has reached an initial set. Use light pre-watering between coats when rapid drying conditions exist.

5. Sandwich (Topping) Application: When treated structural slabs are to receive a concrete or other topping, place the topping while waterproofing material is still "green" but has reached an initial set. Lightly pre-water when rapid drying conditions exist.

H. Curing:

1. General: Begin curing as soon as Xypex coating has hardened sufficiently so as not to be damaged by a fine spray. Cure Xypex treatment with a mist fog spray of clean water three times a day for 2 to 3 days, or cover treated surfaces with damp burlap for the prescribed period. In warm climates, more than three sprayings per day may be necessary to prevent excessive drying of coating.
2. Air Circulation: Do not lay plastic sheeting directly on the waterproofing coating as air contact is required for proper curing. If poor circulation exists in treated areas, it may be necessary to provide fans or blown air to aid in curing of waterproofing treatment.
3. Holding Structures: For concrete holding structures such as swimming pools reservoirs, water treatment tanks and wet wells, cure Xypex treatment for three days and then allow treatment to set (air cure) for 12 days before filling structure with liquid. For structures holding hot or corrosive liquids, cure waterproofing treatment for three days and allow to set for 18 days before filling.
4. Protection: During the curing period, protect treated surfaces from damage by wind sun, rain and temperatures below 36oF (2oC). If plastic sheeting is used for protection, it must be raised off of waterproofing coating to allow sufficient air circulation.
5. Curing Agent: If moist curing is not possible, use a chemical curing agent that is specifically designed for or compatible with the approved crystalline waterproofing treatment. Curing agent shall have at least two years of successful field use and shall be approved by waterproofing manufacturer in writing.

I. Interface with Other Materials:

1. Backfilling: Do not backfill for 36 hours after application. If backfill takes place within seven days after application, then backfill material shall be moist so as not to draw moisture from waterproof coating.
2. Paint, Epoxy or Similar Coatings: Do not apply paint or other coatings until waterproofing treatment has cured and set for a minimum of 21 days. Before applying paint or coating, neutralize treated surface by dampening with water and then washing waterproofed surface with 15% muriatic acid, diluted in a ratio of one part acid to four parts water by volume. Flush acid off treated concrete surfaces.
3. Grout, Cement Parge Coat, Plaster or Stucco: Because the waterproof coating forms a relatively smooth surface and the resulting crystalline formation fills the concrete pores thereby reducing suction characteristics of the concrete, it may be necessary to use a suitable bonding agent for proper bonding of cementitious systems. Trial applications are recommended to ensure that adhesion requirements are satisfied.
4. Responsibility to Ensure Compatibility: Xypex Chemical Corporation makes no representations or warranties regarding compatibility of Xypex treatment with coatings, plasters, stuccos, tiles or other surface-applied materials. It shall be the responsibility of the installer of the surface-applied material that is to be applied over the Xypex waterproofing treatment, to take whatever measures are necessary, including testing, to ensure acceptance by or adhesion to the waterproofing treatment.

### **3.10 CONSTRUCTION TOLERANCES**

- A. Dimensions and Locations of Elements:
  - 1. For dimensions in cross section or elevation do not vary by more than plus  $\frac{1}{2}$  inch or minus  $\frac{1}{4}$ -inch.
  - 2. For location of elements in plan do not vary from that indicated by more than plus or minus  $\frac{1}{2}$ -inch.
  - 3. For location of elements in elevation do not vary from that indicated by more than plus or minus  $\frac{1}{4}$ -inch in a story height or  $\frac{1}{2}$ -inch total.
- B. Lines and Levels:
  - 1. For bed joints and top surfaces of bearing walls do not vary from level by more than  $\frac{1}{4}$ -inch in 10 feet or  $\frac{1}{2}$ -inch maximum.
  - 2. For conspicuous horizontal lines, such as lintels, sills, parapets and reveals, do not vary from level by more than  $\frac{1}{8}$  inch in 10 feet,  $\frac{1}{4}$ -inch in 20 feet or  $\frac{1}{2}$ -inch, maximum.
  - 3. For vertical lines and surfaces do not vary from plumb by more than  $\frac{1}{4}$ -inch in 10 feet,  $\frac{3}{8}$  inch in 20 feet or  $\frac{1}{2}$ -inch maximum.
  - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals and expansions and control joints, do not vary from plumb by more than  $\frac{1}{8}$  inch in 10 feet,  $\frac{1}{4}$ -inch in 20 feet or  $\frac{1}{2}$ -inch maximum.
  - 5. For lines and surfaces do not vary from straight by more than  $\frac{1}{4}$ -inch in 10 feet,  $\frac{3}{8}$  inch in 20 feet or  $\frac{1}{2}$ -inch maximum.
  - 6. For vertical alignment of exposed head joints, do not vary from plumb by more than  $\frac{1}{4}$ -inch in 10 feet or  $\frac{1}{2}$ -inch maximum.
  - 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than  $\frac{1}{16}$  inch except due to warpage of masonry units within tolerances specified for warpage of units.
- C. Joints:
  - 1. For bed joints, do not vary from thickness indicated by more than plus or minus  $\frac{1}{8}$  inch with a maximum thickness limited to  $\frac{1}{2}$ -inch.
  - 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than  $\frac{1}{8}$  inch.
  - 3. For head and collar joints, do not vary from thickness indicated by more than plus  $\frac{3}{8}$  inch or minus  $\frac{1}{4}$ -inch.
  - 4. For exposed head joints, do not vary from thickness indicated by more than plus or minus  $\frac{1}{8}$ .

### **3.11 FIELD QUALITY CONTROL**

- A. Owner will engage a qualified independent testing agency to perform field quality-control testing indicated below.
  - 1. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
- B. Testing Frequency: Tests and Evaluations listed in this Article will be performed during construction for each 5000 sq. ft. of wall area or portion thereof.
- C. Mortar properties will be tested per UBC Standard 21-16.
- D. Grout will be sampled and tested for compressive strength per UBC Standard 21-18.
- E. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

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- F. Prism-Test Method: For each type of wall construction indicated, masonry prisms will be tested per UBC Standard 21-17, and as follows:
1. Prepare 1 set of prisms for testing at 7 days and 1 set for testing at 28 days.

### 3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
  3. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
  4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
  5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.

### 3.13 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as fill Material: dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches in each dimension.
  2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste.
  3. Do not dispose of masonry waste as fill within 24 inches of finished grade.
- C. Excess Masonry Waste: remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste and legally dispose of off Project Site.

**END OF SECTION**

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**SECTION 323352 – SITE FORMED CONCRETE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Cast-in-place concrete for use in retaining walls and non-structural formed concrete construction in landscaping work.
- B. Referenced Sections:
  - 1. Section 012500 - Substitution Procedures.
  - 2. Section 013300 - Submittal Procedures.
  - 3. Section 014339 - Mockups.
  - 4. Section 014500 - Quality Control: General requirements for testing and special inspection.
  - 5. Section 017419 - Construction Waste Management and Disposal.
  - 11. Section 321313 - Concrete Paving.
- C. Mockups: The work of this Section is subject to mock-up requirements described in Section 014339.

**1.02 REFERENCED STANDARDS**

- A. ASTM International (ASTM):{2019}
  - 1. A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
  - 2. A1064 - Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
  - 3. C33 - Specification for Concrete Aggregates.
  - 4. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  - 5. C94 - Specification for Ready-Mixed Concrete.
  - 6. C109 - Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
  - 7. C150 - Specification for Portland Cement.
  - 8. C171 - Specification for Sheet Materials for Curing Concrete.
  - 9. C219 - Terminology Relating to Hydraulic Cement.
  - 10. C260 - Specification for Air-Entraining Admixtures for Concrete.
  - 11. C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
  - 12. C494 - Specification for Chemical Admixtures for Concrete.
  - 13. C618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
  - 14. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
  - 15. C979 Specification for Pigments for Integrally Colored Concrete.
  - 16. C1059 - Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
  - 17. C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
  - 18. C1116 - Specification for Fiber-Reinforced Concrete and Shotcrete.
  - 19. C1315 - Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
  - 20. D448 - Classification for Sizes of Aggregate for Road and Bridge Construction.
  - 21. D1751 - Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types).

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- 22. D1752 - Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- 23. D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
- 24. E1745 - Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
- B. California Code of Regulations (CCR):
  - 1. CBSC, Title 17 - Public Health , current edition.
    - a. Division 3. Air Resources
      - 1) Chapter 1. Air Resources Board:
        - a) Subchapter 8.5. Consumer Products.
          - (1) Article 2. Consumer Products.
            - (a) Section 94507 - Applicability.
- C. California Code of Regulations (CCR):
  - 1. CBSC, Title 24, Part 2- California Building Code (CBC), 2019 edition.
    - a. Chapter 19A - Concrete.
- D. California Code of Regulations (CCR):
  - 1. CBSC, Title 24, Part 11 - California Green Building Standards Code (CALGreen), 2019 edition.
- E. American Concrete Institute (ACI):
  - 1. ACI Manual of Concrete Practice, latest edition.
    - a. 117 - Standard Tolerances for Concrete Construction and Materials.
    - b. 301 - Specifications for Structural Concrete for Buildings.
      - 1) SP-15 - Field Reference Manual: Specifications for Structural Concrete for Buildings  
ACI 301 with Selected ACI and ASTM References.
    - c. 306.1 - Standard Specifications for Cold Weather Concreting.
    - d. 308 - Standard Practice for Curing Concrete.
    - e. 318 - Building Code Requirements for Reinforced Concrete.
- F. American Welding Society (AWS):
  - 1. D1.4 - Structural Welding Code - Reinforcing Steel.
- G. Concrete Reinforcing Steel Institute (CRSI):
  - 1. Manual of Standard Practice.
- H. United States Green Building Council (USGBC): {LEED ONLY}
  - 1. Leadership in Energy and Environmental Design (LEED):
    - a. Green Building Rating System.

### 1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.
- B. Coordination: Refer to Section 018113 regarding procedures for implementing sustainable design requirements. {LEED ONLY}

### 1.04 SUBMITTALS

- A. Product Data: In accordance with the provisions of Section 013300, submit complete manufacturer's descriptive literature and specifications for products proposed for use.

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1. Comply with submittal requirements in ACI 301.
2. Indicate type of corrosion resistant reinforcing proposed and locations, if applicable.
- B. Shop Drawings: Submit Shop Drawings indicating the proposed location of construction joints, and the locations and configurations of other features that will affect the appearance of exposed concrete.
  1. Include: offsets, reveals, and depressions.
  2. Indicate location of form ties on exposed concrete walls.
  3. Indicate method of forming when form ties are not permitted on exposed concrete walls.
- C. Samples: Submit samples of concrete finish not less than 12 inches by 12 inches in size for review and acceptance.
- D. Quality Control Submittals: Submit the following items to Architect for information only:
  1. Design Data: Submit design mix data for each type of concrete and each compressive strength required on the Contract Drawings. Submittal of mix designs shall not relieve Contractor of its responsibility to furnish concrete of proper consistency and specified strengths.
    - a. Design mix submittal shall be wet stamped and signed by a professional engineer licensed in the State of California.
    - b. For each material, including admixtures and water, state water-cement ratio and maximum allowable water content.
    - c. For each material, state manufacturer's name, designation, and source.
    - d. Submit shrinkage and creep factors for each type of aggregate, and each source proposed for use, for acceptance-review.
    - e. For each mix design:
      - 1) Pay costs associated with mix design preparation.
      - 2) Consider concrete cover and clear distances between reinforcing bars as indicated on the Contract Drawings in determining the aggregate size for mix designs. This may result in an aggregate size smaller than specified elsewhere in this Specification.
      - 3) Submit a schedule which identifies the locations within the structure where each mix design is proposed for use.
  2. Test Reports: Submit certified laboratory test reports to Architect confirming physical characteristics of materials used in the performance of the work of this Section.
  3. Placement Schedule: Prepare a placement schedule and submit to Architect for review and acceptance prior to start of concrete placement operations.
  4. Field Reports: Maintain an accurate record of the items listed below. Keep records available for review at the site. Upon completion of work of this Section, deliver two copies of each record to structural engineer in form acceptable to Architect.
    - a. Batch Ticket: Furnish information for each batch discharged and used in the work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.
    - b. Concrete Placement: Date and time of placement in each portion of schedule. Include starting and ending temperatures, humidities, and wind velocities.
    - c. Test Cylinders: Cross-reference to placement record entries.

### 1.05 QUALITY ASSURANCE

- A. Qualifications:
  1. Testing Laboratory Qualifications for Mix Designs: Regularly engaged and specializing, for the preceding 10 years, in the preparation of mix formulae for structural concrete.

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- a. Testing laboratory shall be acceptable to the enforcement agency and the Owner.
  2. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment. Manufacturer shall be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
  3. Installer Qualifications: An experienced installer who has completed concrete work 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.
  4. Designer Qualifications: A structural engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- B. Mockups: Refer to Section 014339 for mockup requirements. Mockup installations shall be located on site as indicated on the Contract Drawings or as directed by Architect. Mockups are separate from field samples used in actual construction, and shall be removed after completion of paving work.
1. Install mockup of each distinct \*item indicating color, jointing, texture, and overall workmanship for review and acceptance.
  2. Mockups shall be a representative portion of the wall approximately 4 feet long.
  3. Provide mockups identical in every respect to completed work.
  4. When accepted, mockups will become the standards by which subsequent work of this Section will be evaluated for acceptance.
  5. Refer to Section 014339 Article 1.02 for definitions of Mockups and Field Samples.
- C. Source Limitations: Obtain each type of cement of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Acceptable Manufacturers of Accessory Products:
1. Fibermesh Company, Chattanooga, TN (615)892-7243.
  2. Five Star Products, Inc., Fairfield, CT (203)336-7900, (800)336-7900.
  3. Euclid Chemical Company, Cleveland, OH (800)321-7628.
  4. L&M Construction Chemicals, Inc., Omaha, NE (402)453-6600, (800)362-3331.
  5. Master Builders Technologies, division of Degussa, Cleveland, OH (216)831-5500, (800)228-3318, (714)476-0500 [Admixtures], (800)824-8441 [Construction Products].
  6. ProSoCo, Inc., Lawrence, KS (800)255-4255, with representation in Southern California (949)498-7077, [www.prosoco.com](http://www.prosoco.com).
  7. Sinak Corporation, San Diego, CA (619)231-1771.
  8. W.R. Grace and Co.-Conn., Construction Product Division, Cambridge, MA (617)876-1400, (800)635-2308, with sales offices in Costa Mesa, CA (800)852-0568.
- B. Acceptable Manufacturers of Retarder Products:
1. Architectural Concrete Chemicals, Capitol Heights, MD (301)336-9300, [www.acchemicals.com](http://www.acchemicals.com).

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2. Grace Construction Products (Top Cast and Face Off), Customer Service Center, (877)813-1710, [www.graceconstructionproducts.com](http://www.graceconstructionproducts.com), or Mike Davis, California Representative: Innovative Concrete Products, (949)498-7077.
- C. Like materials shall be the products of one manufacturer and shall be either the ones upon which the design is based or equal products of other manufacturers accepted in advance in accordance with Section 012500.

### 2.02 REGULATORY REQUIREMENTS

- A. Regulatory Requirements: Refer to Section 014500 with regard to compliance with applicable codes and regulations.
  1. Comply with ACI 301 and ACI 318 for interpreting design requirements of reinforced concrete.
    - a. Section 1.6.1 of ACI 301 requires that Contractor keep a copy of ACI SP-15 in the field office of any project where ACI 301 requirements are referenced.
  2. Comply with, regulations of the air quality management district in force at the time of the performance of the work of this Section with regard to sealers and curing compounds.
  3. When field sandblasting is performed, conform to the requirements of the air quality management district in force at the time of the performance of such work.
- B. Waste Management: Comply with CBSC, Title 24, Part 11 CALGreen. Establish a construction waste management plan for the diverted material.
  1. Recycle and/or salvage for reuse a minimum of 65 percent of the nonhazardous construction and demolition waste in accordance with CALGreen 5.408.1 - Construction Waste Management Plan.
    - a. Include carpet, wood, aggregate, paint, shingles, wallboard, and other materials that have recyclable value.
  2. Reuse and recycle 100 percent of trees, stumps, rocks, and associated vegetation and soils resulting primarily from land clearing in accordance with CALGreen 5.408.3 - Excavated Soil and Land Clearing Debris.
  3. Submit documentation to enforcing agency which demonstrates compliance with CALGreen 5.408.1.4 - Documentation. Sample compliance forms are available in the CALGreen Guide.
- C. Comply with CALGreen 5.504.4.1 Adhesives, Sealants, and Caulks: Adhesives, sealants, primers, and caulks in amounts greater than 16 ounces shall comply with SCAQMD Rule 1168 VOC limits, as indicated in Tables 5.504.4.1 and 5.504.4.2.
  1. Aerosol adhesives and smaller sizes of adhesives and sealant or caulking shall comply with CCR Title 17, commencing with Section 94507.

### 2.03 FORMWORK

- A. Furnish formwork and form accessories according to ACI 301.
  1. Matte As-Cast Finish: Medium-Density Overlay (MDO), with mill-applied release agent and edge sealant. Provide one of the following panels, or equal product:
    - a. Olympic Panel Products, B-Matte 333 MDO Concrete Form.
      - 1) Overlay Color: Brown.
    - b. Pacific Laminate Products, ProFace MDO.
      - 1) Overlay Color: Black.
    - c. Sylvan Products, LLC, Armor Ply MDO.
  2. Provide new forms specifically purchased for this project. Reuse of forms from past projects or contractors stock will not be accepted.

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3. Provide custom form boards as required to align seams with reveals indicated on Contract Drawings.

### 2.04 REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 1064, as drawn.
- C. Plain-Steel Welded Wire Fabric: ASTM A 1064, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Fabric: ASTM A 1064, flat sheet.
- E. Fibrous Reinforcement: Refer to Section 032400.
  1. Comply with ASTM C 1116, Type III, Section 4.1.3 and ASTM C 1116 Performance Level I1 as outlined in Section 21 Note 17. Provide one of the following, or equal:
    - a. Fibermesh: 100 percent virgin polypropylene fibrillated fibers specifically manufactured for use as concrete secondary reinforcement.
    - b. W.R. Grace: 100 percent virgin polypropylene fibrillated fibers specifically manufactured for use as concrete secondary reinforcement.
  2. Provide in lengths and deniers required to provide optimum strength, reduce cracking, and long-term durability.
  3. Nylon fiber materials are not acceptable.

### 2.05 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II/V, or Type V, as required.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 3/8-inch nominal size.
  1. Fine Aggregate: Washed natural sand consisting of hard, particles, containing not more than the maximum limits of deleterious material allowed by Table 1 of ASTM C 33.
    - a. Fineness modulus shall be in the range of 2.90 to 3.10.
    - b. Exposed Aggregate: Coachella Sand.
  2. Coarse Aggregate: Smooth, uncoated, washed, graded natural gravel, 3/8-inch in largest dimension. Color shall be in the tan or brown ranges, as selected by the Architect.
    - a. Do not use crusher-run stone or bank-run gravel.
- C. Fly Ash: Conform to ASTM C 618 Class F. Fly ash shall not experience a loss of ignition greater than 2 percent.
- D. Water: Potable and complying with ASTM C 94.

### 2.06 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride. Acceptable products:
  1. Air-Entraining Admixture: ASTM C 260.
  2. Water-Reducing Admixture: ASTM C 494, Type A.
  3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
  4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
  5. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
  6. Shrinkage Reducing: Eclipse, manufactured by Grace Construction Products.

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- B. Integral Color Admixture: Integral color oxide pigment admixture, in accordance with ASTM C 979. Provide Chromix-L, as manufactured by L.M. Scofield, or equal, in Type 2 colors stipulated by Architect.

- 1. As specified on Contract Drawings.

### 2.07 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  - 1. Material shall become an integral part of concrete surface and leave floor free of residue or film.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Curing Compound: Clear, waterborne, membrane-forming curing compound conforming to ASTM C 309, Type 1, Class B.
  - 1. Curing and Sealing Compound: Clear, waterborne, membrane-forming curing and sealing compound conforming to ASTM C 1315, Type 1, Class A.
    - a. Provide type that dissipates without leaving a shiny, cloudy, or glossy finish.

### 2.08 GROUT MATERIALS

- A. Patching Mortar:
  - 1. Horizontal: Polymer modified portland cement mortar for horizontal patching, equal to one of the following:
    - a. Durapatch Industrial, manufactured by L&M Construction Chemicals.
    - b. Emaco R310, manufactured by Master Builders.
  - 2. Vertical: Polymer modified portland cement mortar for vertical and overhead patching, equal to one of the following:
    - a. Durapatch VOH, manufactured by L&M Construction Chemicals.
    - b. Emaco R350, manufactured by Master Builders.

### 2.09 RELATED MATERIALS

- A. Vapor Retarder: One of the following:
  - 1. Multi-ply reinforced polyethylene sheet, ASTM E 1745, Class C, not less than 7.8 mils thick, or...
  - 2. Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.
  - 3. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils (0.25 mm) thick.
- B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.
- C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- D. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- E. Sealer: Sure Klean Weather Seal Siloxane PD as manufactured by ProSoCo, or equal.

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- F. Surface Retarder: One of the following, or equal.
  - 1. Top-Cast, manufactured by Grace Construction Products.
  - 2. Euro-Tard, manufactured by Grace Construction Products.
  - 3. Optimus, manufactured by Architectural Concrete Chemicals.
- G. Chairs, Bolsters, Bar Supports, and Spacers:
  - 1. Corrosion Resistance:
    - a. Provide plastic coated, plastic-tipped (CRSI Class 1) or stainless steel types at exposed-to-view concrete surfaces.
    - b. Provide only stainless steel (CRSI Class 2) at exterior exposed surfaces.

### 2.10 PROPORTIONING

- A. Comply with ACI 301 requirements for concrete mixtures.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
  - 2. Proportion concrete mix for each class of concrete to achieve the strengths (28 days) and slumps noted on the Contract Drawings.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash: 10 to 15 percent maximum.
  - 2. Combined Fly Ash and Pozzolan: 25 percent.
  - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
  - 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
- C. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:
  - 1. Comply with requirements of this Section for installation, sealing, and protection of subslab moisture barrier.
  - 2. Concrete Mix:
    - a. Water-to-cement content shall not exceed a ratio of 0.48 after the addition of water at site.
    - b. Use water reducing admixture in concrete mix.
    - c. Do not use calcium chloride admixtures.
      - 1) Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
    - d. Concrete strength at 28 days shall be at least **\*\*3000\*\*3500\*\*4000** psi.
    - e. Slump: 4 inches.
      - \*1) Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches after adding admixture to plant- or site-verified, 2- to 3-inch slump concrete.
  - 3. Provide continuous moisture option for curing as specified in Paragraph 3.09-Error! Reference source not found..
- \*D. Maximum Water-Cementitious Materials Ratio:
  - 1. 0.50 for concrete required to have low water permeability.
  - 2. 0.50 for concrete subject to moderate sulfate exposure.
  - 3. 0.45 for concrete subject to severe or very severe sulfate exposure.
  - 4. 0.45 for concrete exposed to deicers or subject to freezing and thawing while moist.

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5. 0.40 for corrosion protection of steel reinforcement in concrete exposed to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater, or spray from these sources.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
  1. Use water-reducing admixture or high-range water-reducing admixture (super-plasticizer) in concrete, as required, for placement and workability.
  2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 6.0 percent within a tolerance of plus 1.0 or minus 1.5 percent.
  1. Air content of trowel-finished interior concrete floors shall not exceed 3.0 percent.
- G. Fibrous Reinforcement: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
- H. Corrosion-Inhibiting Admixture: Add Corrosion-Inhibiting Admixture to concrete in contact with soil deemed to be corrosive.

### 2.11 MIXING CONCRETE

- A. Ready-Mixed Concrete: Comply with ASTM C 94 and ASTM C 1116.
  1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degrees F, reduce mixing and delivery time to 60 minutes.
- B. Weather Requirements: Adjust mix as required to counteract effects of anticipated or probable hot weather on strength of concrete. Conform to ACI recommendations of regarding admixtures, temperature of mixing water, and delivery times.
  1. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact shall be free from frost. Frozen materials or materials containing ice shall not be used.
  2. When mixing concrete during freezing or near-freezing weather, the mix shall have a temperature of at least 50 degrees F., but not more than 90 degrees F. The concrete shall be maintained at a temperature of at least 50 degrees F. for not less than 72 hours after placing. When necessary, concrete materials shall be heated before mixing. Special precautions shall be taken for the protection of transit-mixed concrete.
- C. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
  1. For mixer capacity of 1 cubic yard or smaller, continue mixing at least one and one-half minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
  2. For mixer capacity larger than 1 cubic yard, increase mixing time by 15 seconds for each additional 1 cubic yard.
  3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

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## **2.12 SOURCE QUALITY CONTROL**

- A. Defective Concrete: The following list includes, but is not limited to, concrete that will be deemed to be defective and non-conforming:
  - 1. Concrete not formed as indicated, not true to alignment indicated, not plumb where intended, not level where intended, or not true to level or elevation intended.
  - 2. Concrete voided or honeycombed, including voids and honeycombs that have been cut, resurfaced, or filled without prior approval of the Architect.
  - 3. Concrete with exposed reinforcement.
  - 4. Concrete with inadequate cover over reinforcement.
  - 5. Concrete with embedded foreign objects and debris, including sawdust, wood or metal shavings, nails, cans, trash.
  - 6. Concrete that does not visually match the accepted mockups, or the designated design reference sample.
  - 7. Other non-conforming work that affects the appearance or functionality of the work.
- B. Concrete deemed to be defective by the Architect or in non-conformance with the Contract Documents shall be removed and replaced from expansion joint or cold joint to next expansion joint or cold joint at no cost to the Owner.
- C. Defective concrete shall be removed and replaced with work complying with the requirements of the Contract.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Preinstallation Testing:
  - 1. Damage Repair: In presence of Architect, damage a part of the exposed surface for each finish, color, and texture of mockups, and demonstrate materials and techniques proposed for repair of tie holes, honeycombing, spalls, and surface blemishes to match adjacent undamaged surfaces.
    - a. Repeat testing until results match acceptable work.

### **3.02 FORMWORK**

- A. Design, construct, erect, shore, brace, and maintain formwork according to ACI 301.
- B. Tolerances: Comply with ACI 117.

### **3.03 STEEL REINFORCEMENT**

- A. Comply with CRSI Manual for fabricating, placing, and supporting reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

### **3.04 JOINTS**

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Locate and install so as not to impair strength or appearance of concrete, at locations indicated or as approved by Architect.
  - 1. Location of joints are subject to approval of the Architect. Construction joints locations shall align with reveal locations as located on Contract Drawings. Provide custom form boards as

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required for joint alignment indicated on drawings. Do not place expansion material at cold joints.

- C. Isolation (Expansion) Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
- D. Contraction (Control) Joints: Form weakened-plane contraction joints, sectioning concrete in both directions equal to two feet for each inch thickness of the concrete slab. Construct contraction joints for a depth equal to at least one-third of the concrete thickness, as follows:
  - 1. Tooled Joints: Refer to Section 321313.
  - 2. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8-inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
  - 3. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- E. Reveals: Form reveals at cold joints, continuous at walls, vertically and at tops, in accordance with Contract Drawings.

### 3.05 CONCRETE PLACEMENT

- A. Comply with ACI recommendations for measuring, mixing, transporting, placing, and consolidating concrete.
- B. Do not add water to concrete during delivery, at Project site, or during placement.
- C. Consolidate concrete with mechanical vibrating equipment.
- D. Hot Weather Placing: Comply with ACI recommendations regarding placing of concrete during hot weather.
  - 1. Take accepted measures to reduce evaporation and temperature of concrete during hot, dry weather.
- E. Cold Weather Placing: Comply with ACI recommendations regarding placing of concrete during cold weather.
  - 1. Take accepted measures to prevent freezing.

### 3.06 FINISHING FORMED SURFACES

- A. Textured Finish: While the surface is still plastic, provide a textured finish as indicated on the Contract Drawings, or as directed by the Architect in accordance with the following paragraphs.
- B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material 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.
  - 1. Apply to concrete surfaces not exposed to public view, concrete surfaces not covered with a coating, or covering material applied directly to concrete such as waterproofing, dampproofing, veneer plaster, or paint.

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- C. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Completely remove fins and other projections.
  - 1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or paint.
  - 2. Do not apply rubbed finish to smooth-formed finish.
  - 3. Apply the following rubbed finish, defined in ACI 301, to smooth-formed finished concrete.
    - a. Smooth-rubbed finish.
    - b. Grout-cleaned finish.
    - c. Cork-floated finish.
- D. Smooth-Trowelled Finish: As-cast concrete texture imparted by form-facing material with steel trowel finish. Repair and patch tie holes and defective areas. Completely remove fins and other projections.
  - 1. Apply to concrete surfaces exposed to public view.
  - 2. Apply the following rubbed finish, defined in ACI 301, to smooth-formed finished concrete, as directed by Architect.
    - a. Smooth-rubbed finish.
    - b. Grout-cleaned finish.
    - c. Cork-floated finish.
    - d. Sponged-finish.
- F. Painted Finish: Entire surface area of wall panels exposed to view shall be free of voids, cracks, spalls, protrusions, or non-uniform textures.
  - 1. Prior to sacking, prepare surfaces in accordance with Section 099100.
  - 2. Entire surface area of concrete exposed to view shall be repaired, resurfaced, and made ready to receive paint finish specified under Section 099100.
    - a. Resurfacing of concrete panel surfaces shall be accomplished with specified resurfacing materials in accordance with manufacturer's instructions and the preparation and application procedures of ACI 503.4.
- G. Surface Retarder Finish: TopCast No. 3 Light Etch.
  - 1. Appearance: Slab surfaces shall exhibit an aggregate exposure of fine aggregate particles constituting not less than 60 percent and not more than 80 percent of the surface, as directed by Architect. Exposure shall be of sufficient depth to provide a surface profile of between 1/16-inch and 3/16-inch.
- H. Related 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.
- I. Sealing: Treat surfaces of exterior exposed formed concrete with sealer specified in Article 2.09.

### 3.07 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

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- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleed water appears on the surface.
  - 1. Do not further disturb surfaces before starting finishing operations.
- C. Scratch Finish: Apply scratch finish to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, and other bonded cementitious floor finish, unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, or built-up or membrane roofing.
- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
- F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where tile materials are to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

### 3.08 TOLERANCES

- A. Variations in finish surfaces shall not exceed the following, as recommended by ACI 117:
  - 1. Formed Surfaces: Maintain bowing, warping, and dimensional tolerances within the following maximums:
    - a. Overall Dimension for Height and Width: Plus zero to minus 3/32-inch for surfaces that are 10 feet and over.
    - b. Thickness: Plus-or-minus 1/8-inch maximum.
    - c. Openings: Accurate to within a tolerance of plus 1/8-inch to minus zero.

### 3.09 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Follow ACI recommendations for hot-weather protection during curing. Comply with ACI 306.1 for cold-weather protection.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot per hour before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. Curing Methods: Curing method shall be consistent with recommendations of ACI 308. Cure formed and unformed concrete for at least seven days by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

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1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
  - a. Water.
  - b. Continuous water-fog spray.
  - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article. Tests will be performed according to ACI 301.
  1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cubic yard, but less than 25 cubic yard, plus one set for each additional 50 cubic yard or fraction thereof.
  2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
- B. Frequency of Testing: Test will be made in accordance with ASTM C 39, ACI 318, and CBC Section 1905A.6.

### 3.11 ADJUSTING

- A. Patching Formed Concrete: Site concrete with imperfections shall be removed and replaced as established in Article 3.01.

### 3.12 CLEANING

- A. Wash and clean flatwork surfaces. Leave free from oil, paint, plaster, form coating, and other foreign substances, ready to receive scheduled finishes.

### 3.13 PROTECTION

- A. Protect textured surface with graffiti-resistant coating specified in Section 099623.

**END OF SECTION**

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**SECTION 328400 – PLANTING IRRIGATION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for the insidental to performing the proper completion of work for irrigation systems for exterior landscape planting areas, as shown in the Contract Drawings, and as specified herein this section.
- B. Referenced Sections:
  - 1. Section 011100 - Summary of Work.
  - 2. Section 012500 - Substitution Procedures.
  - 3. Section 013113 - Project Coordination.
  - 4. Section 013300 - Submittal Procedures.
  - 5. Section 014500 - Quality Control.
  - 6. Section 017700 - Contract Closeout.
  - 7. Section 017823 - Operating and Maintenance Data.
  - 8. Section 017836 - Product Warranties and Bonds.
  - 9. Section 017839 - Project Record Documents.
  - 10. Section 017419 - Construction Waste Management and Disposal.
  - 12. Section 320190 - Landscape Maintenance.
  - 13. Division 26 Electrical Sections: General requirements for electrical work.
- C. Related Sections:
  - 1. Section 025639 - Temporary Tree and Plant Protection.
  - 2. Section 312219 – Landscape Grading.
  - 3. Section 329200 – Soil Preparation.
  - 4. Section 329000 - Planting.
  - 5. Section 329400 – Landscape Planting Accessories.
  - 6. Division 22 Plumbing Sections: General requirements for piping and appurtenant work.
- D. Related Requirements:

**1.02 REFERENCES**

- A. ASTM International (ASTM):{2018}
  - 1. A536 - Specification for Ductile Iron Castings.
  - 2. B62 - Specification for Composition Bronze or Ounce Metal Castings.
  - 3. D1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
  - 4. D1785 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  - 5. D2241 - Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
  - 6. D2287 - Specification for Non-rigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
  - 7. D2464- Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  - 8. D2466 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

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9. D2564 - Specification for Solvent Chemicals for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
  10. D2672 - Specification for Joints for IPS PVC Pipe Using Solvent Cement.
  11. D2855 - Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
  12. F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
  13. F512 - Specifications for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
- B. California Code of Regulations (CCR):
1. CBSC, Title 24, Part 2- California Building Code (CBC), 2019 edition.
- C. California Code of Regulations (CCR):
1. CBSC, Title 24, Part 3 - California Electrical Code (CEC), 2019 edition.
- D. California Code of Regulations (CCR):
1. CBSC, Title 24, Part 11 - California Green Building Standards Code (CALGreen), 2019 edition.
- G. National Fire Protection Association (NFPA):
1. 70 - National Electric Code (NEC), latest edition.
- H. National Sanitation Foundation (NSF):
1. Requirements for Seal of Approval.
- I. Plastics Pipe Institute (PPI):
1. Recommendations for hydrostatic design stresses for PVC pipe.

### 1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
1. The Irrigation Contractor shall coordinate with the Contractor for installation of required sleeving as shown on the plans.
  2. Prior to work of this Section, carefully review the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
  3. Verify that irrigation system may be installed in accordance with pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- B. Coordinate with the requirements affecting planting irrigation work as specified in Section 011100, Section 013113, and Section 014500.
- C. Coordination: Refer to Section 017419 regarding procedures for implementing construction waste management requirements.
- E. Preinstallation Conference: Before work commences, schedule a conference with the Landscape Architect regarding requirements of the work of this Section.
- F. Permits: Apply for and secure required permits.

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#### 1.04 SUBMITTALS

A. 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 irrigation system materials, or processes proposed to be furnished and installed as part of this contract.
2. The submittals shall include the following information:
  - a. A title sheet with the job name, the contractors 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. Catalog cuts shall be one or two pages from the most recent manufacturers catalog that indicate the product submitted. Do not submit parts lists, exploded diagrams, price lists or other extra information.
  - d. Catalog cuts shall clearly indicate the manufacturers name and the item model number. The item model number, 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.
  - f. Submittal Format Requirements:
    - 1) Submittals shall be provided as one complete package for the project. Multiple partial submittals will not be reviewed.
    - 2) 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.
    - 3) Submittal package shall have pages numbered in the lower right hand corner. Page numbers shall correspond with submittal index.
    - 4) 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.
3. Landscape Architect or Owner's authorized representative will allow no substitutions without prior written acceptance.
4. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.
5. Landscape Architect or Owner's authorized representative will not review the submittal package unless provided in the format described above.

B. Product Data: In accordance with the provisions of Section 013300, submit complete manufacturer's descriptive literature and specifications. Include complete lists of materials proposed for use, giving the manufacturer's name, catalog number, and catalog cut for each item specified.

1. Prepare typewritten material list using the following format. Double space between each item:

ITEM NO.	DESCRIPTION	MANUFACTURER	MODEL NO.
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2. No substitution will be allowed without prior written acceptance by the Landscape Architect or Owner's authorized representative.



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3. Manufacturer's warranties shall not relieve the Contractor of its responsibility under the guaranty. Such warranties shall only supplement the guaranty.

C. Quality Control Submittals:

1. Test Reports: When necessary, and as directed by the Landscape Architect, submit certified laboratory test reports confirming physical characteristics of materials used in the performance of the work of this Section.
2. Certifications: Provide electrical wiring, controls, motors, and devices be listed and labeled by Underwriters Laboratories, Inc. (UL).
3. Manufacturer's Instructions: Submit the manufacturer's recommended methods of installation, including relevant limitations.

### 1.05 CLOSEOUT SUBMITTALS

A. General Closeout Procedures: Refer to Section 017700.

B. Closeout Submittals:

1. Project Record Documents: Record information on a daily basis and submit in accordance with Section 017839.
  - a. Record accurately on one set of drawings changes in the work constituting departures from the original Contract Drawings and the actual final installed locations of required components as shown below.
    - 1) Show locations with plan dimensions from two permanent points of reference, such as building corners, sidewalks, or curbs, the location of the following items:
      - a) Point of connection (including water meters and POC, basket strainers, master control valves, and flow sensors.
      - b) Routing of main pressure sprinkler lines, with dimensions shown at a maximum interval of 100 feet along routing.
      - c) The routing of control and common wiring.
      - d) Connection to existing electrical power.
      - e) Electric remote control valves.
      - f) Connection to existing water source.
      - g) Backflow preventer/basket strainers and water meter as existing features.
      - h) Irrigation controllers.
      - i) Gate and ball valves.
      - j) Quick coupling valves.
      - k) Other related equipment.
    - 2) Show locations and depths of the following items:
      - a) Isolation valves.
      - b) Automatic remote control valves, indicating station numbers and sizes.
      - c) Quick coupling valves.
      - d) Drip air relief and flush valves.
      - d) Routing of control wires where separate from irrigation mainline.
      - e) Irrigation controllers, indicate controller numbers and station counts. Include related equipment as may be directed by Architect.
  - b. The record drawings shall be prepared to the satisfaction of the owner. Prior to final inspection of work, submit record controller drawings to the Landscape Architect or Owner's authorized representative.
  - c. Record drawings shall be prepared using Revit Release 2021 drafting software and the original irrigation drawings as a base. No manually drafted record drawings will be

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- accepted The Contractor may obtain digital base files from the Landscape Architect or Owner's authorized representative.
- d. 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.
  - e. 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 Revit Release 2021 drawing file. Digital files shall be provided on a compact disc (CD) clearly marked with the project name, file descriptions and date.
  - f. Record drawing information and dimensions shall be collected on a day-to-day basis during the installation of the pressure mainline to fully indicate routing locations and pipe depths. Locations for other irrigation equipment shall be collected prior to the final inspection of the work,
  - g. 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. Irrigation symbols shall be clearly shown matching the irrigation legend for the Contract Documents. Lettering on the record drawings shall be minimum 1/8 inch in size.
  - h. Irrigation controllers (indicate controller number and station count) Related equipment (as may be directed).
  - i. 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 highlighters pens. A minimum of six individual colors shall be used for the controller chart unless less than six control valves are indicated.
  - j. Landscape Architect or Owner's authorized representative must approve record drawings before controller charts are prepared.
  - k. 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.
  - l. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils in thickness.
2. Controller Charts: Submit in accordance with Section 017823.
- a. Prepare charts after Project Record Drawings have been accepted by Landscape Architect.
  - b. Provide one chart for each automatic controller as follows:
    - 1) Chart shall be a reproduction of the Record Drawings, if the scale permits fitting onto the controller door. If photo reduction prints are required, keep reduction to maximum size possible to retain full legibility.
    - 2) Chart shall be blackline print of the actual As-Built system, showing the area covered by the controller.
    - 3) Provide one chart for each controller.
  - c. Identify the area of coverage of each remote control valve, using a distinctly different translucent pastel color, drawn over the entire area of coverage.

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- d. Following acceptance, hermetically seal charts between two layers of 10-mil thick plastic sheet.
    - e. Charts shall be completed and accepted prior to final review of irrigation system.
  3. Checklists: Provide two copies of the signed and dated checklist and submit in accordance with Section 017823 prior to final review of the work.
    - a. Use the following format:
      - 1) Plumbing Permits: If not required, so note.
      - 2) Material Reviews: Accepted by and date.
      - 3) Pressure Line Tests: By whom and date.
      - 4) Record Drawings: Received by and date.
      - 5) Controller Charts: Received by and date.
      - 6) Materials and Equipment Furnished: Received by and date.
      - 7) Operating and Maintenance Data: Received by and date.
      - 8) System and Equipment Operation Instructions: Received by and date.
      - 9) Manufacturer's Warranties (if required): Received by and date.
      - 10) Written Guaranty: Received by and date.
      - 11) Lowering of Heads in Lawn Areas: If incomplete, so state.
      - 12) Manufacturers and phone numbers.
    - b. Include index sheet stating contractor's and equipment manufacturer's name, address, and phone number.
  4. Operation and Maintenance Manuals:
    - a. 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 site observation visit. The manuals shall describe the material installed and the proper operation of the system.
    - b. Each complete, bound manual shall include the following information:
      - 1) Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment including names and addresses of local manufacturer representatives.
      - 2) Operating and maintenance instructions for equipment.
      - 3) Spare parts lists and related manufacturer information for equipment.
  5. Warranty Forms: Submit warranty forms in accordance with Section 017836.

### 1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish the following tools as a part of this Contract:
  1. Two sets of keys for each automatic controller cabinet.
  2. One valve box key for every 12 lock lid valve boxes used in this installation.
  3. Six quick coupler keys and matching hose swivels for each size and type of quick coupling valve.
  4. Two quick coupler keys with a 1-inch bronze hose bib, bent nose type with hand wheel and two coupler lid keys.
  5. Three 30-inch sprinkler keys for manual operation of control valves.
  6. Two sprinklers (with complete set of nozzles) for each used in the installation.
  7. Two wrenches for disassembly and assembly, or adjustment, or removal of each type sprinkler head and valve used in this installation.
  8. One Oakfield Type B soil probe.
  9. Two 5-foot long valve keys for gate valves.
    - a. Two 5-foot tee wrench for operating gate valves 3 inches or larger (if used).

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10. For specified gate valves, if required: One 5-foot long valve handle, to specified gate valves.
11. Drip Irrigation Spare Parts:
  - a. Two (2) Plastic handled punch.
  - b. 500 feet of dripper tubing for each dripper interval and discharge rate.
  - c. (25) barbed couplings.
  - d. (25) barbed 90-degree elbows fittings.
  - e. (25) barbed tee fittings.
  - f. 180-degree two-way adapter tees.
  - g. (25) male adapters with ¾-inch FPT.
  - h. Five (5) spare filter element of the mesh size indicated on the Irrigation Legend.
  - i. Five (5) line-flushing valves.
  - j. (10) regulator springs of the colored and regulating pressure indicated on the Irrigation Legend.
  - k. (25) dripper plug rings.

### 1.07 QUALITY ASSURANCE

#### A. Qualifications:

1. Installer's Qualifications: Regularly engaged, and specializing, for the preceding 5 years, in the installation of equivalent irrigation systems using solvent-gasket joints.
2. Valid California C-27 Landscape License.
3. Installer's Field Supervision: Installer to maintain an experienced English-speaking full-time supervisor at the Project Site during times that Work under this Section is in progress and who shall be thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation.

#### B. Supplemental Qualifications:

1. Potable Water Piping, from the Point of Connection (POC) to the Backflow Prevention Assembly, shall be installed by a Contractor who is licensed to perform this Work.
2. Non-Potable Water Piping, from the Point of Connection (POC) to the irrigation Water Meter shall be installed by a Contractor who is licensed to perform this Work.
3. Electrical Power (110v and above) shall be installed by a Contractor who is licensed to perform this Work.
4. Contractor shall demonstrate completion of the Manufacturer's installation certification program for the specified computer-controlled irrigation system.

#### C. Field Measurements:

1. Make necessary measurements in the field to ensure precise fit of items in accordance with the original design. Contractor shall coordinate the installation of irrigation materials with other work.
2. Scaled dimensions are approximate. The Contractor shall check and verify scaled dimensions prior to proceeding with work under this Section.

- D. Observations: Landscape Architect may observe the installation of Irrigation Systems at Project Site for compliance with requirements for type, size, and quality of Work. Landscape Architect retains the right to observe Irrigation Systems for defects and to reject unsatisfactory or defective material at any time during the progress of Work. Contractor shall remove rejected materials immediately from Project Site.

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- E. Manufacturer's Directions: Manufacturer's directions and detailed drawings of the Manufacturer shall be followed in all cases where the Manufacturer of products used under this Contract furnishes directions covering points not shown in the Contract Drawings and Specifications.
- F. Single-Source Responsibility: Obtain each color, type, and variety of products/materials from a single source with resources to provide products/materials of consistent quality in appearance and physical properties without delaying Work.
- G. Permits, Fees, Bonds, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, testing services, utility services, and inspections necessary to perform and complete Work under this Section. Contractor is responsible for costs of temporary services.
  - 1. 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.
  - 2. Provide a Backflow Report Form completed by a Certified Backflow Tester. The test shall be done in the presence of District Inspector. A copy of the Backflow Report Form shall be submitted to the District Inspector.

### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials bundled, in manufacturer's original packaging and with identifying labels and markings affixed and legible. Pipe shall be transported in a vehicle which allows the length of the pipe to lie flat.
- B. Storage: Store materials off-ground and protected from damage.
  - 1. Store pipe flat and fully supported.
- C. Damaged Materials: Irrigation materials that have been damaged during delivery or storage shall be discarded and replaced.
- D. Use means necessary to protect irrigation system materials before, during, and after installation and to protect the installation work and materials of other trades. In the event of damage, immediately make repairs and replacements necessary to the acceptance of the Landscape Architect and Owner and at no additional cost to the Owner.
- E. 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.

### 1.09 FIELD CONDITIONS

- A. Existing Conditions:
  - 1. The Contractor shall verify and be familiar with the locations, size and detail of points of connection provided as the source of water, electrical supply, and telephone line connection to the irrigation system.
  - 2. Irrigation design is based on the available static water pressure shown on the Contract Documents. Contractor shall verify static water on the project prior to the start of construction.
    - a. Should a discrepancy exist, notify the Landscape Architect and Owner's authorized representative prior to beginning construction. Should a discrepancy exist, notify the Landscape Architect and Owner's authorized representative prior to beginning construction.

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3. Prior to cutting into the soil, the Contractor shall locate 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.
  4. The Contractor shall protect existing utilities and features to remain on and adjacent to the project site during construction. Contractor shall repair, at his own cost; damage resulting from his operations or negligence.
  5. Sleeves and Conduits: Installation of all sleeves and conduits to be located under paving (and through walls and footings) prior to placement of those materials.
  6. The Contractor shall verify and be familiar with the existing irrigation systems in areas adjacent to and within the Project area of work.
  7. The Contractor shall protect existing irrigation systems, in areas adjacent to and within the project area of work, from damage due to his operations.
  8. 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.
  9. The Contractor shall repair or replace 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. Repairs shall be complete to the satisfaction of the Owner's Representative.
7. On-Structure Equipment:
- a. Coordinate connections of irrigation system and the water source with Plumbing Contractor.
  - b. Once irrigation piping and risers have been installed through the structural deck (slab) and waterproofing has been installed and has been accepted, install the irrigation piping and risers within the on-structure planting areas.
- B. Coordination of Existing Irrigation System:
1. Refer to Existing Irrigation Notes on Contract Drawings for coordination with, and modifications to, existing irrigation system within limits of work.

### 1.10 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with Controller and Automatic Control Valves.
- B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain one-hundred-percent (100%) head to head irrigation coverage of areas indicated.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
  1. Irrigation Main Piping: 200 PSI.
  2. Circuit (Lateral) Piping: 126 PSI.
- D. Construction Drawings: Due to the scale of the Contract Drawings, it is not possible to indicate all offsets, fittings, sleeves, etc. which may be required. Contractor shall carefully investigate the structural and finished conditions affecting all of his Work and plan his Work accordingly, furnishing

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such fittings, etc. as may be required to meet such conditions. Irrigation System as delineated in the Contract Drawings are generally diagrammatic and indicative of the Work to be installed. Work shall be installed in such a manner as to avoid conflicts between the Irrigation System(s), landscape planting, utilities, and/or architectural/site features.

1. The Design Intent of the Landscape Contract Drawings is meant to prioritize and highlight the features and locations of the landscape planting rather than the location and/or Contractor's convenience of installing the Irrigation System. As such, the location of landscape planting takes precedence over the location of the Irrigation System components. For instance, in locations where a continuous hedge is delineated on the landscape planting plans, this hedge shall not be interrupted nor broken by the location(s) of errantly placed valve box(es) or subsurface piping run(s) that is servicing the Irrigation System. The Irrigation System components shall be located in a manner that the landscape planting design or its design intent is not compromised. Any Irrigation System component that is found to be in conflict with the location or design intent of the landscape planting shall be removed and relocated accordingly by the Contractor through the direction of the Landscape Architect. Contractor shall not be entitled to any additional compensation and the Owner shall not incur additional costs from Contractor with the directed removal and relocation of such Irrigation System components.
- E. Work called for on the Contract Drawings by notes or details shall be provided whether or not specifically mentioned in the Specifications. When an item is shown on the Contract Drawings but not shown on the Specifications or vice versa, it shall be deemed to be as shown on both. Landscape Architect shall have final authority for clarification.
- F. Contractor shall not willfully install the landscape Irrigation System as shown on the Contract 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 and Owner's Authorized Representative as soon as detected. In the event this notification is not performed, the Contractor shall assume full responsibility for any revision necessary.

#### **1.11 WARRANTY**

- A. The entire sprinkler system, including work done under this contract, shall be unconditionally guaranteed against defects and fault of material and workmanship, including settling of backfilled areas below grade, for a period of one year following the filing of the Notice of Completion. 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 10 calendar days of receipt of notice from Owner. When the nature of the repairs constitute an emergency (i.e. broken pressure line), Owner may proceed to make repairs at the Contractor's expense. Any damages to existing improvements resulting either from faulty workmanship, or from the necessary repairs to correct same shall be repaired to the satisfaction of the Owner by the Contractor, at no additional cost to the Owner.
- B. During the warranty period, the Owner reserves the right to make temporary repairs as necessary to maintain the irrigation system equipment in operating condition. The exercise of this right by the Owner shall not relieve the Contractor of his responsibilities under the terms of the warranty.

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- C. Guarantee shall be submitted on Contractor's own letterhead as follows:

### GUARANTEE FOR SPRINKLER IRRIGATION SYSTEM

We hereby guarantee that the sprinkler irrigation systems we have furnished and installed, is free from defects in materials and workmanship, and the work has been completed in accordance with the Contract Documents 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.

PROJECT NAME:

PROJECT LOCATION:

CONTRACTOR NAME:

ADDRESS:

TELEPHONE:

SIGNED:

DATE:

- D. 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 damage to planting, paving or other improvements of any kind as a result of the repair work.
- E. 25-Year HDPE Pipe Warranty

A. AquaFuse Product Warranty:

1. Limited Warranty: Seller warrants that, for a period of twenty-five (25) years from the date of shipment, it will replace any section of CMF Global, AquaFuse HDPE pipe, fittings and valves product that is defective in materials or workmanship, provided that Buyer, upon discovery of a defect, promptly notifies Seller of the defect and, as instructed by Seller at such time, either returns the product to Seller for inspection or allows Seller to inspect at the place of installation. If Seller determines the product to be defective, Seller will provide new product of the same specification and same quantity as the defective product and Seller will bear the expense of freight to deliver the replacement product to the jobsite for domestic projects, and to the closest USA port for foreign projects.
2. Seller does not warrant the installation of product. Any defects introduced after the shipment of product by Seller, whether due to handling, installation or other cause, are not covered by this Limited Warranty. This Limited Warranty does not cover labor nor other costs of installing products. Buyer's sole remedy for defective product shall be to receive replacement product as provided in this Limited Warranty.
3. Other than the above Limited Warranty, Seller makes no warranty and expressly disclaims all other warranties, express or implied, including, but not limited to, the warranties of merchantability and fitness for a particular purpose. Seller's liability arising out of or related to this Contract or any product or service supplied by Seller

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(whether such liability is alleged as a breach of Contract, breach of Warranty, misrepresentation, negligence, indemnification, product liability or otherwise) shall in no event exceed the original purchase price of the defective product plus applicable freight costs actually paid by Buyer.

4. Seller will not be liable for any consequential, incidental, special, indirect or punitive damages, loss of profits, loss of business opportunity or other loss even if Seller knew or should have known of the possibility of such damages or losses.

### B. Contractor's Warranty:

1. **Limited Warranty:** Contractor warrants that, for a period of five (5) years (to twenty-five (25) years) from the date of installation, it will re-fuse or repair a fusion connection that is defective in workmanship, provided that Buyer, upon discovery of a defect, promptly notifies Contractor of the defect and, allows the Contractor to inspect at the place of installation. If it is determined the fused connection to be defective, Contractor will re-fuse or repair the connection at the jobsite. Contractor does not warrant the product itself, only the fused connection. This Warranty does not cover labor or other costs, only the fused connection. Buyer's sole remedy for defective connection shall be to receive replacement fusion of the pipe or fitting as provided in this Warranty.
2. Other than the above Limited Warranty, Contractor makes no Warranty and expressly disclaims all other warranties, express or implied, including, but not limited to, the warranties of merchantability and fitness for a particular purpose.
3. Contractor's liability arising out of or related to this Contract or any product or service supplied by Contractor (whether such liability is alleged as a breach of Contract, breach of Warranty, misrepresentation, negligence, indemnification, product liability or otherwise) shall in no event exceed the original purchase price of the defective connection plus applicable freight costs actually paid by Buyer. Contractor will not be liable for any consequential, incidental, special, indirect or punitive damages, loss of profits, loss of business opportunity or other loss even if Contractor knew or should have known of the possibility of such damages or losses.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

#### A. Acceptable Manufacturers:

1. Brooks Products, Inc., Stockton, CA (209)464-7696.
2. Carson Industries, Inc., La Verne, CA (909)596-1988.
3. Hunter Industries, San Marcos, CA (619)744-5240, (800)383-4747.
4. Koppers Industries, Inc., Pittsburgh, PA (412)227-2001, (800)558-2706.
5. Rain Bird Sprinkler Manufacturing Corporation, Glendora, CA (818)963-9311.
6. Salco Products, Hawthorne, CA (310)973-2400.
7. Scotch-Lok, 3M Construction Market Division, St Paul, MN (800)480-1704.
8. Snap-Tite Hose, Union City, PA (814)438-7616.
9. T. Christy Enterprises, Orange, CA (714)771-4142.
10. Telsco Industries.
11. The Toro Company, Irrigation Division, Riverside, CA (909)688-9221.

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- B. Miscellaneous Equipment: Equipment such as rain sensors, flow meters, and master valves shall be of the manufacturer, size, and type indicated on the Contract Drawings.
- C. Substitutions: Substitution procedures shall be governed by the provisions of Section 012500.

### **2.02 REGULATORY REQUIREMENTS**

- A. Regulations:
  - 1. Comply with local, municipal, and state laws, and rules and regulations.
  - 2. Conform to applicable provisions of the latest editions of the Uniform Plumbing Code, the California Electrical Code, and codes properly governing the materials and work at the project site.
  - 3. Electrical materials and work shall conform with California Electrical Code, Basic Electrical Regulations, Article 18 E 110-16.
  - 4. Comply with the City of Irvine Standard Plans and Specifications, including IRWD requirements.
  - 5. Comply with all local, municipal, and California state laws, rules, and regulations governing or relating to any portion of this work.
    - a. If any provisions contained in this Section is construed to conflict with applicable rules and regulations, comply with the regulations. However, when these specifications and Contract Documents call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the regulations, but also comply with the regulations, the provisions of the Contract Drawings shall be implemented.
  - 6. Contractor shall secure the required licenses and permits, make payments of charges and fees, give required notices to public authorities, and verify permits secured or arrangements made by others affecting the work of this Section.

### **2.03 MATERIALS**

- A. Use only new materials of the manufacturer, size and type shown on the Contract Drawings.
  - 1. 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.
- B. Conduit: Low voltage control wire conduit, 1-inch diameter and larger: Gray, UL-listed, PVC, Schedule 40 electrical conduit ASTM F512.
- C. Conduit: ASTM D1785 Schedule 80 PVC.
- D. Landscape Fabric: Landscape fabric for valve box assemblies shall be 5.0-ounce weight woven polypropylene weed barrier, and have a burst strength of 225 psi, a puncture strength of 60 pounds, and capable of water flow of 12 gallons per minute per square foot, equal to DeWitt Pro 5 Seed Barrier.
  - 1. Type: DeWitt Pro 5 Weed Barrier, or equal.

### **2.04 PIPING AND FITTINGS**

- A. Solvent Weld Pipe: Virgin polyvinyl chloride compound manufactured in accordance with ASTM D2241 or ASTM D1784, Class 12454-B. Hydrostatic design stress rating 2,000 psi.
  - 1. Fittings: Standard weight, ASTM D2466 Schedule 40 and ASTM D2466 Schedule 80, injection molded solvent-weld PVC.

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- B. Copper Pipe and Fittings:
  - 1. Pipe: Type K, hard tempered.
  - 2. Fittings: Wrought copper, solder joint type.
  - 3. Piping within structure or building footprint, shall be Copper Tube ASTM B88, Type L, watertube, annealed temper.
  - 4. Joints shall be soldered with silver solder, 45 percent silver, 15 percent copper, 16 percent zinc, and 24 percent cadmium. Solid at 1125 degrees F and liquid at 1145 degrees F.
- C. Brass Pipe and Fittings:
  - 1. Brass pipe shall be 85 percent red brass, ANSI, IPS Standard 125 pounds, Schedule 40 screwed pipe.
  - 2. Fittings shall be medium brass, screwed 125 pound class, FS WW-P-460.
- D. Metal:
  - 1. Galvanized Pipe: ANSI Schedule 40 mild steel with threaded connections.
  - 2. Fittings: Medium galvanized, screwed, beaded malleable iron. Galvanized couplings may be merchant couplings.
  - 3. When installed below grade, paint with two coats of Koppers No. 50 Bitumastic, or equal.
- E. Pressure Piping: Pressure supply lines 2 inches in diameter and larger downstream of the backflow unit shall be Class 315 pipe shall be made from an NSF approved Type I, Grade I, PVC compound conforming to ASTM resin specification D1784. All pipe must meet requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension (S.D.R.) (Solvent-weld Pipe).
  - 1. Point of Connections to **\*\*Backflow Preventer\*\***Basket Strainer:
    - a. Provide copper or brass piping.
- F. Downstream of Backflow Preventer:
  - a. Size Up to 1-1/2-Inch Diameter Type I, Grade I, Schedule 40 PVC in accordance with ASTM D1785.
- G. Non-Pressure Piping:
  - 1. Downstream of Remote Control Valves:
    - a. Size 3/4-Inch and larger:
      - 1) Schedule 40 solvent weld PVC conforming to ASTM D1785.
    - b. Comply with general requirements for pressure lines specified above.
    - c. Offsets shall be a minimum 4-inch unless contractor receives written approval from the Landscape Architect.
    - d. Pipe shall be sized to maintain a velocity in the pipe of less than 4-feet per second at all times.
- H. Fittings:
  - 1. 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.
  - 2. Plastic pipe shall be extruded of an improved PVC virgin pipe compound in accordance with ASTM D2672, ASTM D2241, or ASTM D1785.
  - 3. Solvent weld PVC fittings shall be standard weight Schedule 40 (and Schedule 80 where specified on the irrigation detail sheet) and shall be injection molded of an improved virgin PVC fitting compound. Slip PVC fittings shall be the deep socket bracketed type. Threaded plastic

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- fittings shall be injection molded. Tees and ells shall be side gated. Fittings shall conform to ASTM D2464 and ASTM D2466.
4. Threaded nipples shall be standard weight Schedule 80 with molded threads and shall conform to ASTM D1785.
  5. 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 ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.
- I. Exposed Piping:
1. General: Integral gray color, brownline UVR, PVC pipe.
    - a. PVC pipe installed on grade shall be Schedule 40 ultra-violet resistant (UVR) PVC pipe manufactured with a distinguishing brown color and marked with the manufacturer's name and a UVR designation.
    - b. PVC fittings used with UVR pipe shall be Schedule 40 UVR PVC type.
  2. Threaded Risers and Nipples: ASTM D1785 Schedule 80 PVC.
  3. Other Risers and Fittings: ASTM D1785 Schedule 40 PVC, solvent weld.
- J. Sleeves:
1. Four Inches and Smaller: ASTM D1785 Schedule 40 PVC.
  2. Larger Than 4 inches, but Less Than 6 Inches:
    - a. ASTM D1784 Class 12454-C (formerly Type I, Grade 2, Class 315) PVC.
    - b. ASTM D2241 Class 315 solvent weld PVC.
  3. Larger Than 6 Inches:
    - a. ASTM D2241 Class 200 solvent weld PVC.
- K. Identification: Design is based on Polyurethane Behr Desopaid as manufactured by T. Christy Enterprises, or equal.
1. Identify pipe and fittings with the following indelible and continuous markings:
    - a. Manufacturer's name.
    - b. Nominal pipe size.
    - c. Schedule or class.
    - d. Pressure rating, in psi.
    - e. NSF Seal of Approval.
    - f. Date of extrusion.
- L. 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.
- M. Plastic pipe shall be extruded of an improved PVC virgin pipe compound in accordance with ASTM D2672, ASTM D2241 or ASTM D1785.
- N. Solvent weld PVC fittings shall be standard weight Schedule 40 (and Schedule 80 where specified on the irrigation detail sheet) 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. Tees and ells shall be side gated. Fittings shall conform to ASTM D2464 and ASTM D2466.
- O. Threaded nipples shall be standard weight Schedule 80 with molded threads and shall conform to ASTM D1785.

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- P. 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 ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.
- Q. 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.
- R. Hdpe Pipe And Fittings
1. Pressure supply lines 2-inches and diameter and larger downstream of the backflow prevention unit shall be DR 11 (202 PSI rated) high density polyethylene (HDPE) pipe manufactured from PE 4710 resin compound.
  2. Pressure supply lines two-inches (2") in diameter and larger downstream of the point of connection shall be High Density Polyethylene (HDPE) iron pipe size (IPS) pressure rated PE4710, DR 11 (200 PSI rated) conforming to ASTM F714.
  3. Non-pressure (lateral) lines and drip system headers downstream of the remote control valve shall be High Density Polyethylene (HDPE) iron pipe size (IPS) pressure-rated PE4710, DR 11 (200 PSI rated) conforming to ASTM F714 for 1-inch sized lines and PE4710, DR 17 (126 PSI rated) conforming to ASTM F714 for 2-inch and 3-inch sized lines. Only sizes 1-inch, 2- inch and 3-inch HDPE pipe shall be used for lateral lines. Lateral line sizing shall follow the pipe sizing chart provided on the Contract Drawings.
  4. Sprinkler head and drip connections to the HDPE non-pressure lateral lines shall be made using a HDPE fusible service saddle with a FIPT outlet.
  5. Push-on fittings for use with HDPE shall be ductile iron fittings, slanted, deep bell, gasketed-style manufactured in accordance with ASTM A-536, Grade 65-45-12. Fittings shall have four (4) lugs to accommodate joint restraints and other fittings. Bell section shall allow 5-degree freedom of pipe deflection within the bell end. Gasket design shall be rib-enforced "U- Cup" configuration.
  6. Pipe and tubing shall be manufactured from a PE4710 resin listed with the Plastic Pipe Institute as TR-4. The PE 4710 resin material will meet the specifications of ASTM D3350, with a minimum cell classification of PE 445474C. Pipe shall be manufactured to the dimensions and requirements of ASTM F714. Pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All HDPE pipe shall be in straight lengths or coils.
  7. Physical properties of the HDPE material shall conform to the ASTM 3340 allowable values as shown below:

<i>Associated Property for Cell Class 445474C</i>	<i>Specification</i>	<i>Allowable Values</i>	<i>Typical Values</i>
Density (g/cm <sup>3</sup> )	ASTM D1505	>0.9555	>0.961
Melt Index (g/min.)	ASTM D1238	<0.150	<0.150

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Flexural Modulus (PSI)	ASTM D790	110,000 to <160,000	125,000
Tensile Strength at Yield (PSI)	ASTM D638	3,500 to <4,000	3650
Slow Crack Growth Resistance Pent (Hours)	ASTM F1473	500	>500
Hydrostatic Design Basis At 73.4° F (PSI)	ASTM D2837	1,600 / 1,000	1,600 /1,000
Black Color UV Stabilizer	ASTM D3350	Min. 2%	Avg. 2.25%

8. HDPE pipe shall be AquaFuse, as supplied for CMF Global (740)-953-0589), or equal, as approved by the Landscape Architect.
9. HDPE pipe lengths shall be joined using a butt fusion method approved by the manufacturer of the HDPE pipe, Landscape Architect, and Owner's Authorized Representative. Electrofusion fittings shall be acceptable only in areas where butt fusion is impractical due to site conditions.
10. Butt Fusion Fittings: Fittings shall be PE 4710 with a minimum cell classification of PE 445474C. Butt Fusion molded Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have the same minimum pressure rating as the pipe unless otherwise specified on the Drawings. Fabricated fittings are to be manufactured to meet the FM (Factory Mutual) performance standards. Fabricated fittings are to be manufactured using a Data Logger. Reference to the Data Logger quality control records should be referenced from an indented stamp in each fusion bead of each fitting. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records.
11. Flanged and Mechanical Joint Adapters: Flanged and Mechanical Joint Adapters shall be PE 4710 resin with a minimum cell classification of PE 445474C. Flange adapters and Mechanical Joint Adapters shall have the same pressure rating as the pipe unless otherwise specified on the Drawings.
12. HDPE supplier must be capable of supplying both the pipe and fittings. Supplier must have the capability to train the Contractor in butt fusion, electro-fusion, socket fusion, sidewall saddle fusion and compatible fusion of HDPE pipe and fittings. Supplier must be capable of providing a "Fusion Technical Hot Line", (740)953-0589, to assist in fusion and fusion equipment questions. Supplier must be capable of providing a trained representative on site upon the request of the Contractor, Owner or Landscape Architect to address any problems that are

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encountered during installation. Supplier must furnish a written 25-year limited Warranty for HDPE pipe fittings and valves.

13. HDPE pipe shall be AquaFuse as supplied for CMF Global (hot line), or equal. Recommended HDPE pipe and fitting supplier: CMF Global.

14. Transition fittings for HDPE pipe shall be of the following types.

a. For transitions between HDPE pipe and the emergency shut off valves and the master control valve, the transition shall be made using a fused HDPE x MIPT stainless steel transition fitting. Fittings shall be used in conjunction with a malleable iron union and a ductile iron threaded nipple into the valve. The transition fitting assembly shall be used on both the inlet and outlet side of the valve.

b. For transitions between HDPE pipe and the filter assemblies, the transition shall be made using a fused HDPE x FIPT brass transition fitting.

c. For transitions between HDPE pipe and the remote-control valves, the transition shall be made using a fused HDPE x MIPT schedule 80 PVC. The transition fitting shall incorporate a union into the design of the transition fitting. The transition fitting shall be 2" fused HDPE x the valve inlet / outlet sized MIPT. The transition fitting assembly shall be used on both the inlet and outlet side of the valve.

d. For transitions between HDPE pipe and the sprinkler head assemblies, the transition shall be made using a fusible HDPE service saddle with a ¾-inch FIPT outlet.

## **2.05 BELL AND GASKET FITTINGS**

A. Fittings for bell and gasket pressure supply lines shall be ductile iron deep bell type. Fittings shall be manufactured of ductile Iron, Grade 65.45-12 in accordance with ASTM A536. Fitting gaskets shall be in accordance with ASTM F477. Ductile iron fittings shall be manufactured with exterior lugs. Ductile iron fittings shall be as manufactured by Leemco, Inc., Corona, CA.

B. Tee fittings used to connect remote control valve assemblies and quick coupler assemblies to the mainline shall be ductile iron deep bell type. Outlet side of the tee or ell to the valve assembly shall be sized per the diameter of the largest valve in the assembly or a minimum of 2 inches. Ductile iron deep bell type reducers when used with bolt on links are allowable in lieu of reducing tee or ells. PVC pipe to the valve assembly shall be secured to the ductile iron fitting using a joint restraint.

C. Ductile iron fittings and bell and gasket joints within 50 feet of a directional change in the mainline shall be equipped with mechanical joint restraints. The joint restraint shall be capable of securing the PVC pipe directly to the lugs on the ductile iron fittings without the use of bolts, links, and adapters. The joint restraint shall be capable of securing PVC pipe to PVC pipe and PVC pipe to ring joint isolation valves without the use of threaded linkages. Joint restraints shall be as manufactured by Leemco, Inc., Corona, CA.

## **2.06 JOINT CEMENT AND PRIMER**

A. Non-pressure plastic pipe and fittings shall be cemented using a 100 percent active solvent, blue in color.

1. Primer and solvent shall be manufactured by T. Christy Enterprises, or equal.

B. Pressure and non-pressure plastic solvent weld pipe and fittings shall be coated as follows:

1. 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

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consistency, not gel-like or ropy. Solvent cementing shall be in conformance with ASTM D2564 and ASTM D2855.

- C. 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.

### 2.08 VALVES

#### A. Ball Valves:

1. Provide size, type, and manufacturer indicated on Contract Drawings.
2. Conform to AWWA standards.
- \*3. Provide bronze body, stainless steel ball and stem. Ball valves shall have threaded connections.
4. Minimum working pressures shall be not less than 150 psi and shall conform to AWWA standards.

#### B. Gate Valves: Gate valves shall be of the manufacturer, size, and type indicated on the Contract Drawings.

1. Comply with AWWA Standards.
2. Provide line-sized, ASTM B62 brass body, 150 pound saturated steam-rated with screwed joints, non-rising stem, screwed bonnet, solid wedge disc. Provide with 2-inch square operating nut.
3. Provide arrow cast in metal indicating direction of opening.
4. Valve design shall permit replacement of sealing components without removal of valve body from pipeline.
5. Valves 4 inches or larger shall be flanged.

#### C. Butterfly Valves:

1. Butterfly valves shall be of the manufacturer, size, and type indicated on the Contract Documents.
2. Butterfly valves shall have cast iron bodies, and stainless steel stems. Butterfly valves shall have ductile iron porcelain enamel coated disc.
3. Butterfly valves shall have a minimum working pressure of not less than 150 psi and shall conform to AWWA standards.

#### D. Quick Coupler Valves:

1. Quick coupler valves shall be of the manufacturer, size, and type indicated on the Contract Documents.
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-inch female threads opening at base, with two-piece body. Valves to be operated only with a coupler key, designed for that purpose. When coupler key is inserted into valve a positive, watertight connection shall be made between the coupler key and valve.
3. Hinge cover shall be the locking type constructed of brass with a rubber-like vinyl cover and shall be purple in color with the words WARNING--DO NOT DRINK permanently marked on lid.
- 4.

#### E. Swing Check Valves 2 Inches and Smaller: 200 pound WOG bronze construction with replaceable composition, neoprene, or rubber disc, conforming to FS WW-V-51D, Class A, Type IV.

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- F. Anti-Drain Valves: Provide manufacturer, size, and type indicated on the Contract Drawings.
  - 1. Heavy duty virgin PVC construction with FIP thread inlet and outlet.
  - 2. Internal parts shall be stainless steel and neoprene.
  - 3. Field adjustable against drawout from 5 to 40 feet of head, factory set at 12 feet.
  - 4. Provide 18-8 stainless steel springs and valve stems with Buna-N seals.
  - 5. Threaded connections shall be the size of the riser or pipe they are to be installed onto, or the next available size. No slip connection anti-drain valves are allowed.
- G. Remote Control Valves: Provide same manufacturer as controller unless otherwise noted.
  - 1. Valve Type: Spring-loaded, self-cleaning, packless diaphragm activated, normally closed type, equipped with flow control.
  - 2. Valve Body: Brass or plastic as indicated on Contract Drawings.
  - 3. Valve Solenoid: 24-volt AC 4.5-watt maximum, 500-milliamp maximum surge, corrosion-proof, stainless steel construction, epoxy encapsulated to form a single integral unit.
  - 4. Valve manifolds shall have appropriate valve decoders allowing for direct connection to the two-wire path, as required.
  - 4. Provide manual bleeder valve to permit operation in the field without power at the controller.
  - 5. Automatic control valves shall be electrically operated and of the manufacturer, size, and type indicated on the Contract Documents.
  - 6. Electric Control Valve ID Tags: Yellow in background with black letters 2-3/4 inches by 2-1/4 inches.
- H. Master Control Valve Flow Sensor:
  - 1. Master Control Valve Flow Sensor shall have cast iron, epoxy coated bodies, stainless steel and brass bonnet and trim, and FIPT inlet and outlets.
  - 2. Master Control Valve Flow Sensor shall be normally closed, diaphragm type with manual-flow adjustment, and operated by 24V ac solenoid.
  - 3. Master Control Valve Flow Sensor shall have an integral, pulse type, flow sensor to provide flow data to the central control system.
  - 4. Master Control Valve Flow Sensor shall have an integral valve / sensor decoder allowing for direct connection to the two-wire path.
  - 5. Master Control Valve Flow Sensor shall be of the same manufacturer as the central control system.
  - 6. Products and Manufacturers: Subject to compliance with requirements, provide products by the following: Master Control Valve Flow Sensor shall be of the manufacturer, size, and type indicated on the Contract Drawings.
  - 7. Flow sensor control wire shall be of the manufacturer as indicated on the drawings and enclosed in conduit as indicated on the drawings.

### 2.09 VALVE BOXES

- A. Valve Boxes: Rain Bird, Brooks, Carson Industries, or equal.
  - 1. Non-Traffic Type: Green durable weather-resistant plastic material resistant to sunlight and chemical action of soils. Provide box with overlapping type locking black or green cover.
    - a. Valve Boxes: Round green plastic valve box with locking lid marked WATER for gate ball valves. Brand the symbol GV and BV in 2-inch high letters.
      - 1) Extensions: Valve box extensions shall be by the same manufacturer as the valve box.
      - 2) Valve box cover shall be secured with a hidden latch mechanism or bolts.
    - b. Quick Coupling Valve Boxes: 10-inch circular size with locking lid for quick coupling valves. Heat brand QCV in 2-inch high letters.

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- c. Remote Control Valve, Flow Sensors, and Ball Valve Boxes: Box shall be marked IRRIGATION CONTROL VALVE. Brand valve station numbers on top of cover with 2-inch high letters. Automatic control valve, master valve, and ball valve boxes shall be 16"x11"x12" nominal rectangular size. Valve box covers shall be heat branded in 2-inch high letters with either RCV with the valve identification number, MCV, or FS, or BV heat branded onto the cover in 2-inch high letters / numbers.
  - d. Ball valve, Air relief valve, flush valve, and quick coupler valve boxes shall be 10-inch circular size. Valve box covers shall be heat branded in 2-inch high letters with either BV, AR, FV, or QCV.
2. Traffic Type: The cover and box shall be capable of sustaining a load of 1,500 pounds. No valve boxes shall be allowed in paved areas.

### 2.11 IRRIGATION HEADS

- A. Irrigation heads shall be of the manufacturer, size, type, with radius of throw, operating pressure, and discharge rate indicated on the Contract Drawings.
  1. Irrigation heads shall be used as indicated on the Contract Drawings.
  2. Irrigation heads for reclaimed or recycled water shall have purple warning collars.
- B. Riser/swing joint assemblies shall be manufactured in accordance with the irrigation details indicated on the Contract Drawings.
  1. Riser Nipples: Manufacturer in same size as the riser opening in the sprinkler body.

### 2.12 IRRIGATION HEADS

- A. Irrigation heads shall be of the manufacturer, size, type, with radius of throw, operating pressure, and discharge rate indicated on the Contract Drawings.
  1. Irrigation heads shall be used as indicated on the Contract Drawings.
- B. Small Lawn Sprinkler Heads: In accordance with type noted on Contract Drawings.
  1. Body: Plastic or brass, as noted on Contract Drawings, with a 1/2-inch ips inlet.
  2. Nozzles: Plastic or brass with coverage of full, half, quarter, or as noted on Contract Drawings.
    - a. Nozzles shall rise a minimum of 3-1/2 inches.
- C. Spray Nozzles: Weather-matic 200 Series precision molded ABS plastic spray nozzles are designed exclusively for use with 32P, 35P, 36P and 37P pop-up sprinklers and 95P shrub bodies. 200 Series offers the designer a selection of standard and low trajectory nozzles; full circle and 90, 120, 180 and 270-degree part-circle models. 200 series nozzles have a flow adjustment screw.
  1. Matched Precipitation. Full- and part-circle nozzles shall be compatible to the extent that they can be valved together.
- D. Rotary heads shall be impact-type drive rotary, pop-up type, and designed with an integral check valve for control of line drainage. Sprinkler shall be capable of delivering radius and gallons indicated on Contract Drawings. Retraction shall be accomplished by means of a heavy duty stainless steel spring. Sprinkler shall have a riser seal and wiper.
- E. Spray heads shall be 36P as manufactured by Weather-matic Sprinkler Division of Telsco Industries, or equal. Heads shall pop up not less than 3-1/2 inches with spring retraction. Heads shall accept a fixed arc milled brass nozzle, an adjustable brass nozzle and a adjustable plastic nozzle. Heads shall have ratcheted flow tube for arc location purposes and shall be check valve adaptable.
  1. Construction: Body, cover and flow tube shall be high-impact ABS. A stainless steel spring shall provide retraction force. Outside entry of sand and dirt shall be prevented with a

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- polyurethane wiper seal. An under-nozzle strainer shall be provided to prevent in-line dirt from entering the nozzle. Sprinkler heads with CVA flow tube shall accept the field installable CV-30 check valve. Check valve shall open against 12 feet head of water. Internal parts shall be removable with access through a bayonet twist cover. Six and 12-inch pop-ups shall have bottom and side inlets. Arc location shall be by means of a positive stop ratcheting device permitting the arc to be located by depressing flow tube while sprinkler is in operation.
2. Operation: The nozzles shall either provide adjustable flows and areas of coverage at rated pressure requirements in both full-circle and part-circle types or shall be fixed arc in both full- and part-circle types. Nozzles series must have matched precipitations to the extent that full- and part-circle nozzles can be valved together.
- F. Full-Circle and Part-Circle Sprinklers: Gear drive rotary, Model No. 300-00-93 and shall be manufactured by The Toro Company. The sprinkler shall be of pop-up design with an overall height of 6-1/8 inches, a body diameter of 2-3/8 inches, a cap diameter of 3 inches, and a pop-up stroke of 2-3/4 inches. The sprinkler shall be capable of installation at grade level and shall have 3/4 NPT female inlet. Part of Full Circle operation shall be accomplished by the use of an arc plate inserted beneath the nozzle designed to throw a 360 degree pattern. The sprinkler shall be capable of covering 28 feet radius at 35 pounds per square inch pressure with a discharge rate of 4.07 gallons per minute. Water distribution shall be via twelve nozzles mounted in a 1-3/8-inch diameter nozzle turret. Retraction shall be achieved by a heavy duty stainless steel retraction spring. The sprinkler shall have a riser seal and a wiper which permits limited flushing on the up and down stroke to clear away debris from the riser. Rotation shall be accomplished by a sealed, oil packed gear assembly isolated from the water supply.
- G. Tree Irrigators: Provide assemblies as indicated on Contract Drawings, including vents and filters.
- H. Riser/swing joint assemblies shall be manufactured in accordance with the irrigation details indicated on the Contract Drawings.
1. Riser Nipples: Manufacturer in same size as the riser opening in the sprinkler body.

## **2.13 DRIP IRRIGATION SPECIALTIES**

1. Products and Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Drip irrigation equipment shall be of the manufacturers, models, sizes, and flow rates indicated on the Contract Drawings.
2. Single Outlet Drip Emitters: Shall be pressure compensating, barbed inlet and outlet, with a self-piercing inlet barb.
  - a. Body Material: PE or vinyl.
  - b. Flow Rate: 1.0 gallon per hour.
  - c. Additional Equipment: 1/4" vinyl tubing, tubing stake, diffuser / bug cap.
3. In-Line Drip Tubing, with Internally Fused Drip Emitters:
  - a. Tubing: Flexible PE, 17mm diameter, brown external color.
  - b. Emitters: Pressure compensating, turbulent flow, pressure compensating with built-in check valve.
  - c. Flow Rate: 0.60 gallons per hour.
  - d. Emitter Spacing: 12" on center.
  - e. Fittings: 17mm barb type, same manufacturer as tubing.
4. Air/Vacuum Relief Valves: Plastic housing, with corrosion-resistant internal parts.

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5. Drip Flush Valves: 1/2 inch Sch. 40 PVC ball valve with slip end connectors, a 3/4 inch male hose thread x 1/2 inch slip PVC adapter, and a 3/4" female hose thread cap.
6. Stakes: Steel wire stakes (9" length) / jute netting staples.

### 2.14 BACKFLOW PREVENTION UNITS

- A. The backflow prevention unit shall be of the manufacturer, size, and type indicated on the Contract Drawings.
  1. The backflow prevention unit shall be installed in accordance with the requirements set forth by local codes.
  2. The backflow enclosure shall be of the manufacturer, size, and type indicated on the Contract Documents.
  3. Devices shall meet the requirements of ASSE Standard 1013, AWWA Standard C506, and USC Foundation for Cross Connection Control and Hydraulic Research.

### 2.15 AUTOMATIC CONTROLLER

- A. Automatic irrigation system controller shall contain a heavy-duty watertight case and locking hinged cover; be of the manufacturer, size and type shown on the Irrigation Contract Drawings.
  1. Controller enclosure shall be of the manufacturer, size, and type indicated on the Contract Drawings.
  2. Contractor to ensure data or wireless connection, as indicated on the Contract Drawings, as necessary.
- B. Connections: Make connections between controller and remote control valve with direct burial copper wire. Wire shall be No. 14 AWG Type UP 600-volt single conductor type, PVC insulated underground feeder, UL approved.
  1. Pilot wires shall be a different color for each controller. Common wires shall be white with a color stripe matching the controller pilot wire color.
- C. Multi-Wire Path System Wiring:
  1. Bury wire a minimum of 12 inches in depth in same trench as main irrigation line. 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.
  2. Provide a 24-inch expansion curl within 3 feet of each wire connection, change of direction, and at least every 100 feet of wire length.
  3. Splices: Scotch-Lok No. 3576 Connector Sealing Pack, RainBird Pen-Tite wire connector, or equal.
  4. Splices and RCV connections shall be made using Spears DS-400 pre-filled wire connectors, or equal dry-splice method.
  5. Splices and RCV connections shall be made using 3M DBY wire connectors.
- D. 2-Wire Path (Bicoder Systems):
  1. All Remote Control Valves shall be connected to a Bicoder (decoder) to the Two-Wire Path. Bicoders may be single or multiple station unit, each capable of operating two (2) to four (4) Remote Control Valves.
  2. Products and Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Bicoders shall be of the manufacturer, model, and size as indicated on the Contract Drawings.

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Bidding Documents

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- b. Wires shall be two-conductor, solid core, size #12UF AWG direct burial wires manufactured as a twisted pair (one blue and one red) and encased inside a heavy duty, color coded, polyethylene jacket.
3. Products and Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Two-Wire Path shall be of the manufacturer, model, size, and color coding as indicated on the Contract Drawings.

### 2.16 ELECTRICAL

- A. Electrical equipment shall be NEMA Type 4, rainproof for exterior installations. (Type 3R is dust tight/rain tight, Type 4, 4X, and 6P are waterproof)
  1. Conform to local codes and ordinances.
- B. High Voltage: Electrical service to automatic controller shall be in accordance with Division 26 Sections. Provide final hookup to equipment as a part of the work of this Section.
- C. Low Voltage: Connections shall of the manufacturer, size, and type indicated on the Irrigation Contract Drawings.
  1. Connections between controller and remote control valves shall be made with direct burial AWG-UF 600 volt wire, 14 gage or larger, insulation thickness 3/64-inch, utilizing low density high molecular weight polyethylene insulation.
    - a. Remote control wire shall be 14 AWG solid core twisted pair, type as indicated on the Irrigation Contract Drawings.
  2. Splices, where permitted, shall be waterproofed using fusible heat shrink or epoxy-sealed packet type tubing connectors.
  3. Common wires shall be white in color with a different color stripe for each controller.
  4. Ground wires shall be green in color, or bare copper.
    - a. Ground wires shall be a minimum of 6 AWG.
    - b. Connect ground wires to 5/8-inch x 8-inch bonded ground rods.
    - c. Ground irrigation equipment in accordance with manufacturer specifications.
  5. Control wires shall be red. Where two or more controllers are used, they shall be a different color for each controller.
  6. Colors shall be noted on the Controller Charts located on controller door.

### 2.17 MISCELLANEOUS EQUIPMENT

- A. Refer to Article 2.01 - Manufacturers, for miscellaneous items.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verification of Conditions: Refer to Article 1.09 Field Conditions for requirements related to existing conditions.
  1. Verify that grading has been completed.
  2. Do not install irrigation system when field obstructions, grade differences, or discrepancies in area dimensions exist that may not have been considered in the original design.
  3. Exercise care in excavating and working near existing utilities. Be responsible for existing utilities and for damages to utilities which are caused by operations or neglect. Check existing utility drawings and the drawings of other contracts for locations.

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4. Verify locations of existing utilities, whether shown on Contract Drawings or not. Notify Underground Service Alert (800)642-2444, at least 2 working days in advance of performing excavation work.
  5. Information on the Contract Drawings relative to existing conditions is approximate. Deviations required to conform to actual conditions, as approved by the Landscape Architect in writing, shall be made without additional cost.
  6. In the event of discrepancy, immediately notify the Landscape Architect or Owner's authorized representative. Do not proceed with installation in areas of discrepancy until discrepancies have been resolved.
  7. Grades:
    - a. Before starting work, carefully check grades to determine that work may safely proceed, keeping within the specified material depths with respect to finish grade.
    - b. Final grades shall be accepted by the Engineer before work on this Section will be allowed to begin.
  8. Irrigation design is based on the available static water pressure shown on the Contract Documents. 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.
- B. Interpretation of Landscape Drawings:
1. Required offsets, fittings, and sleeves may not be indicated. Carefully investigate structural and finish conditions affecting work and plan work to furnish such fittings as may be required. Contract Drawings are generally diagrammatic and indicative of the work to be installed. Due to the scale of the Contract Drawings, it is not possible to indicate offsets, fittings, and sleeves that may be required to complete the irrigation system.
  2. Before proceeding with work, check and verify dimensions and quantities and inform Landscape Architect in writing of any discrepancy between the Contract Documents and/or the Specifications and actual conditions. No work shall be done in any area where there is such a discrepancy until written approval for the work has been given by the Landscape Architect. Contractor shall assume full responsibility for work installed without approval.
    - a. The Contractor shall verify and be familiar with the locations, size and detail of points of connection provided as the source of water, electrical supply, and telephone line connection to the irrigation system.
  3. Scaled dimensions are approximate. Check and verify site dimensions and notify in writing any discrepancies.
  4. Materials and work shall be installed in such a manner as to avoid conflicts between irrigation system and planting, existing or proposed utilities, and other construction features.
  5. Verify prior to, and during, construction, that the Contract Documents being used for construction reflect the latest revisions, change orders, and plan checks. Contractor shall be able to produce such documents at the request of the Landscape Architect at any time during construction.
  6. Diagrammatic Intent: The Contract Documents 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.

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### **3.02 PREPARATION**

- A. Protection:
  - 1. Protect previously installed work and materials which may be affected by work of this Section.
  - 2. Protect existing utilities and features to remain on and adjacent to the project site during construction. Repair damage resulting from landscape operations or negligence.
- B. Layout:
  - 1. Prior to installation, stake out pressure supply lines, routing and location of sprinkler heads, valves, backflow preventer devices, and automatic controllers.
    - a. Lay out each system using staking method accepted by the Owner. Maintain and protect staking layout. Piping or equipment shown diagrammatically on Contract Documents outside of planting areas shall be installed inside planting areas whenever possible.
  - 2. Layout irrigation system and make minor adjustments required due to differences between actual site and Contract Drawings. Where piping is shown on Contract Documents under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.
  - 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.
  - 4. Water Supply: Connections to, or the installation of, the water supply shall be at the locations shown on the Contract Documents. Minor changes caused by actual site conditions shall be made at no additional expense to Owner.
  - 5. Layout shall be approved by the Landscape Architect in writing prior to installation. If equipment is incorrectly located without said approval, it is the Contractor's responsibility to relocate it in accordance with the Landscape Architect's directions without additional cost.
- C. Electrical Service:
  - 1. Connections to the electrical supply shall be at the locations shown on the Contract Documents. Minor changes caused by actual site conditions shall be made at no additional expense to Owner.
  - 2. Contractor shall make 120 volt connection to the irrigation controllers. Electrical power source to controller locations shall be provided under the work of Division 16.

### **3.03 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 Contract Documents to the depths below finished grade and as noted. Where lines occur under paved area, these dimensions shall be considered below subgrade.
  - 1. Cutting or breaking of existing pavement is not permitted.
    - a. Provide bore holes under 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 (888)650-5554, [www.bulletmole.com](http://www.bulletmole.com), or equal. Bore holes larger than 2 inches in diameter shall be made with an approved mechanical boring tool. No air jacking or hydraulic boring type tools will be allowed.
- B. Prior to trenching into the soil, locate cables, conduits, sewer septic tanks, and other utilities. 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

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Owner to arrange for relocations. The irrigation subcontractor will proceed in the same manner if a rock layer or any other such conditions are encountered.

- C. Provide minimum coverage as follows:
  - 1. Pressure Supply Lines:
    - a. Under Planting Areas: 24 inches minimum.
    - b. Under Vehicular Paved Areas: 36 inches minimum.
    - c. 2-1/2 Inches and Smaller in Size: 18 inches minimum.
    - d. 3 Inches and Larger in Size: 24 inches minimum.
  - 2. Non-pressure Lines: 12 inches minimum.
    - a. 1/2 Inches to 2 1/2 Inches in Size: 18 inches.
    - b. 3 Inches in Size: 24 inches.
    - c. 4 Inches and Larger in Size: 30 inches.
  - 3. Control Wire: As indicated on the Irrigation Contract Drawings.
    - a. 18 inches minimum within planters. Place adjacent to pressure supply lines.
    - b. 24 inches for control wires within sleeves below paving.
- D. Provide not less than 4 inches clearance between each line and not less than 12 inches clearance between lines of other systems in a common trench, unless otherwise indicated on Contract Drawings. Do not install parallel lines directly over any other line.
- E. Protect materials to prevent intrusion of dirt and moisture. Flooding of trenches shall be permitted only with the approval of the Landscape Architect.
- F. Where it is necessary to excavate adjacent to existing trees, the Contractor shall use possible care to avoid injury to trees and tree roots.
  - 1. Excavation in areas where 2-inch and larger roots occur shall be done by hand. Roots 2 inches in diameter, except directly in the path of a pipe conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying.
  - 2. Where a ditching machine is run close to trees having roots smaller than 2 inches in diameter, the wall of the trench adjacent to the tree shall be hand-trimmed, making clean cuts through.
  - 3. Roots 1-inch and larger in diameter shall be painted with two coats of Tree Seal, or equal.
  - 4. Trenches adjacent to trees should be closed within 24 hours, and where this is not possible, the side of the trench adjacent to the tree shall be kept shaded with burlap or canvas.
  - 5. In case of damage to existing trees, the Contractor shall forfeit an amount in proportion to extent of damage determined by the Owner, which amount shall not exceed \$10,000 per tree total loss.

### 3.04 BACKFILLING

- A. Backfill Material: Backfill material on lines shall be the same as adjacent soil, free of debris, litter, and rocks over 1/2 inch in diameter.
  - 1. Existing site material, if approved by the Landscape Architect, shall be used for backfill material. Backfill material shall be free from organic materials, large clods of earth or rocks larger than 1 inch diameter, trash, debris, rubbish, broken cement, asphalt material or other objectionable substances.
  - 2. Imported backfill material, if required, shall be clean soil consisting of earth, sand, sandy clay, loam or other approved materials, with no large clods of earth or rocks larger than 1 inch diameter.
  - 3. Sand backfill shall be fine, granular, unwashed river sand material containing no foreign matter larger than 1/2-inch in size.

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4. Where excavated native soil contains greater than 50 percent rock or other material 1-inch diameter or larger, sand backfill shall be placed 3 inches in depth around pipes.
- B. If settlement occurs and subsequent adjustments in pipe, valves, sprinklers heads, lawn or planting, or other construction are necessary, Contractor will make the required adjustments without cost to the Owner.
- C. 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 a dry density equal to adjacent undisturbed soil and shall conform to adjacent grades.
  1. Compact backfill with mechanical devices to a dry density equal to adjacent undisturbed soil. Restore to adjacent grade, free of dips, depressions, humps, or other irregularities.
  2. Compaction by truck or other vehicle shall not be permitted.
  3. Flooding in lieu of tamping is not allowed.
- D. Cover at Paved Areas: Provide sand backfill a minimum of 6 inches over and under piping under paved areas.
  1. Backfill with sand, one layer 6 inches below pipe and one layer 6 inches above pipe, and compact in layers to 90 percent compaction using mechanical tamping devices. Set in place, cap, and pressure test piping under paving prior to installation of paving work.
  2. Install piping under existing walks by jacking, boring, or hydraulic driving. Cutting or breaking of sidewalks or concrete is not allowed without Landscape Architect's acceptance. No hydraulic driving will be permitted under concrete paving.
  3. Provide for a minimum cover of 24 inches between top of pipe and bottom of paving for pressure and non-pressure piping installed under asphaltic or cement concrete paving.

### 3.05 INSTALLATION

- A. Carefully inspect pipe and fittings before installation, removing dirt, scale, burrs and reaming. Install pipe with markings up for visual inspection and verification.
  1. Remove dented and damaged pipe sections.
- B. Piping under existing pavement may be installed by jacking, boring, or hydraulic driving. No hydraulic driving is permitted under asphalt pavement. Refer to Paragraph 3.03-A.1 in Article: Trenching
  1. Sleeving: Install irrigation and electrical sleeving as indicated on the Contract Drawings. Contractor shall coordinate the installation of sleeves with the work of other trades to ensure installation of underground work precedes paving installation.
- C. Thrust Blocks:
  1. Provide concrete thrust for all pipe as required by the following schedule.

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FITTING SIZE (INCHES)	TEE, WYE, PLUG OR CAP	90° BEND OR PLUGGED CROSS	TEE PLUGGED ON RUN BEND		45° BEND	22 1/2° BEND	11 1/4° BEND	VERTICAL VOLUME OF THRUST BLOCK IN CUBIC YARDS			
			A1	A2				FITTING SIZE	45° BEND	22 1/2° BEND	11 1/4° BEND
04	1.3	1.9	2.5	1.9	1.3	1.3	1.3				
06	2.8	4.0	5.7	4.0	2.1	1.3	1.3	4"	1.1	0.4	0.2
08	5.1	7.1	10.1	7.1	3.9	2.0	1.3	6"	2.7	1.0	0.4
10	7.9	11.2	15.7	11.2	6.1	3.2	1.6	8"	4.0	1.5	0.6
12	11.3	16.0	22.7	16.0	8.8	4.5	2.3	12"	8.5	3.2	1.3
14	15.3	21.7	30.7	21.7	11.9	6.1	3.1	16"	14.8	5.6	2.3
16	20.0	28.4	40.0	28.4	15.5	8.0	4.0	VERTICAL BEND			
18	25.3	36.0	50.7	36.0	19.5	10.1	5.1	FITTING SIZE	ROD SIZE	EMBEDMENT BEND	
20	31.3	44.4	62.7	44.4	24.1	12.5	6.3	4" - 12"	#6	30	
24	45.3	64.0	90.7	64.0	34.9	18.1	9.1	14" - 16"	#8	36	

Above bearing areas based on test pressure of 150 psi and an allowable soil bearing strength of 1,500 pounds per square foot. To compute bearing areas for different test pressures and soil bearing stresses, use the following equation:

$$BEARING AREA = (TEST PRESSURE / 150) \times (1,500 / SOIL BEARING STRESS) \times (TABLE VALUE)$$

2. All thrust blocks shall bear directly on undisturbed earth. Pipe shall be centered in the middle of thrust block. Contractor shall install a plastic barrier between the thrust block and the pipe and/or wires, so as not to encase them in the concrete thrust block.
- D. In solvent welding, use only the specified primer and solvent cement and make joints in strict accordance with the manufacturer's recommended methods including wiping 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.
- E. Connections:
  1. Threaded plastic-to-plastic connections shall be assembled using Teflon tape.
  2. For plastic-to-metal connections, work the metal connections first. Use a non-hardening pipe dope on threaded plastic-to-metal connections, except where noted otherwise. Plastic-to-metal connections shall be made with plastic male adapters.
  3. Galvanized Metal Pipe and Fittings: Assemble using Teflon tape applied to male threads only. Coat below grade portions with 2 coats of protective coating.
  4. Brass Pipe and Fittings: Assemble using Teflon tape applied to male threads only.
- F. Plastic Pipe and Threaded Fittings: Install in accordance with manufacturer's instructions.
  1. Pipes shall be clean and free from moisture and assembled using specified primer and solvent to plastic-to-plastic joints.
  2. Pipe shall be snaked within the trench as much as possible to allow for expansion and contraction.
  3. Assemble plastic pipe and threaded fittings and plastic pipe to metal joints using Teflon tape applied to male threads only. Use only lightweight wrench pressure to tighten.
  4. Routing of irrigation pipe as indicated on the Contract Drawings is diagrammatic. Install lines and various assemblies to conform with the details shown on the Contract Drawings.

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5. Install no multiple assemblies on plastic lines. Provide each assembly with its own outlet.
  6. Install assemblies specified in accordance with respective detail. In absence of detail drawings or specifications pertaining to specific items required to complete work, perform such work in accordance with best standard practice with prior written approval of the Landscape Architect.
  7. Where threaded PVC connections are required, use threaded PVC adapters into which the pipe may be solvent welded.
  8. In changing pipe depth, 45-degree elbows shall be used.
  9. HDPE pipe may be installed in a curved fashion to eliminate fittings at directional changes.
- G. Swing Joints: Provide swing joint assemblies manufactured in accordance with Contract Drawings.
- H. PE and HDPE Piping:
1. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  2. Plain-End PE Pipe and Fittings: Use butt fusion.
  3. After fusing of the joint, using a white Sharpie pen, write the date and time of the joint fusing and the operator's initials clearly onto one side of the joint.
  4. HDPE pipe shall be joined using a butt fusion method approved by the manufacturer, the Irrigation Consultant and the Owner's Authorized representative. Contractor shall provide all necessary equipment and certified operators for the joining and installation of HDPE pipes.
  5. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground, whenever possible. The joining method shall be the butt fusion and or socket fusion method and shall be performed in strict accordance with the pipe supplier's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe supplier, including, but not limited to, temperature requirements of 425 +/- 15 degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 +/- 15 psi for hydraulic. The fusion equipment used shall be manufactured by McElroy Manufacturing, or equal. The butt fusion joining will produce a joint-weld strength equal to or greater than the tensile strength of the pipe itself.
  6. Electro-fusion or socket fusion (500°F +/-25 may be used where the butt fusion method cannot be used. Electro-fusion couplings and fittings shall be PE 4710 with a minimum cell classification of PE 445474C. Electro-fusion couplings or fittings shall have a manufacturing standard of ASTM F1055. Couplings and fittings shall have the same pressure rating as the pipe unless otherwise specified on the Drawings.
  7. Testing: If pressure testing is required, testing shall be done hydrostatically. For detailed testing information contact AquaFuse Irrigation Hot Line, (740-953-0589).
  8. Quality Control Testing (On Site Bend Back Test):
    - a. Prior to HDPE pipe being installed in the trench, at the beginning of the job, Contractor shall cut out the first butt fusion of each pipe size. Contractor shall prepare the sample for the test in accordance with the "Bend Back Testing" procedure in accordance with ASTM F 2620.
    - b. The samples shall be tested in the presence of the Owner's Authorized Representative and / or Landscape Architect, all in accordance with testing procedures outlined. All samples shall be labeled and saved. Testing must be done at 73 degrees F plus or

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minus 5 degrees. The test temperature and sample size are critical to testing. The purpose of the test is to determine if the weld meets specified standards. A pass means no failures during the bend back test. This means a good weld. A break means a bad weld. Any failure shall require additional testing.

- c. For non-pressure lateral lines: The connections to sprinkler head, bubbler heads and drip tubing connections shall be made using a fusible service saddle fused to the HDPE pipe using a heat process and device specifically designed for the purpose.
  - 1) All fusible service saddles shall have 3/4" MIPT connections and be installed onto the top side of the HDPE pipe.
  - 2) For sprinkler and bubbler installations, the service saddles may be installed after the installation of the HDPE pipe to the required depth.
  - 3) For drip tubing installations, Contractor may install the service saddles onto HDPE supply and discharge header pipes prior to installing the pipes. The service saddle spacing shall be at 16" on center to match the recommended drip tubing row spacing. Contractor shall adjust the installation of the completed headers so that at least one (1) edge is aligned with a tubing row within 4" of the paved surface.
- I. Automatic Controllers:
  - 1. Verify location with Landscape Architect. Install in accordance with manufacturer's instructions.
  - 2. Controller shall be securely mounted in the location indicated on the Contract Drawings or approved by the Landscape Architect in such a manner that normal operations can be conveniently made by the operator.
  - 3. Contractor shall properly ground the controllers in accordance with local codes and the Contract Drawings.
  - 4. Contractor shall take control wires to the controller and make required connections for their installation and operation.
  - 5. Electrical and control wires installed above ground shall be placed in metal conduit or other approved materials and securely mounted. Paint conduit as per the Landscape Architect's directions and as indicated on the Contract Drawings.
  - 6. The exact location of the controller shall be approved by the Landscape Architect or Owner's authorized representative before installation. The electrical service shall be coordinated with this location.
  - 8. All controller and two-wire path grounding shall be installed and tested to provide the manufacturer's recommended grounding requirements.
- J. The irrigation system shall be programmed to operate during the periods of minimal use of the design area or in accordance with the irrigation schedule provided.
- K. Irrigation Heads:
  - 1. Install as indicated on Contract Drawings.
  - 2. Install heads along curbs, walks, and paving level with grade in lawn areas.
  - 3. Lower raised heads within 10 days after notification by the Owner.
  - 4. Set heads perpendicular to finished grade, unless otherwise directed by Landscape Architect.
  - 5. Spacing of sprinklers shall not exceed the maximum indicated on the Contract Drawings.
  - 6. Riser units shall be manufactured in accordance with the irrigation details.
  - 7. Riser nipples for sprinklers shall be the same size as the riser opening in the sprinkler body.

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### L. Remote Control Valves:

1. Install where shown on Contract Drawings. When grouped together, allow at least 12 inches between valve boxes and from landscape items.
2. Install each control valve in a separate valve box.
  - 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.
  - c. Provide air space between gravel and remote control valve.
3. Install in accordance with the irrigation details and manufacturer's recommendations.
4. For remote control valves, provide 24 inch expansion loop at electrical connections within control valve boxes.
5. Quick Coupling Valves: Unless otherwise indicated, locate valves within 12 inches of nearest edge of hardscape. Install one valve per valve box. Install in shrub area where possible.
6. Install valve in shrub areas whenever possible.
7. Install valves as indicated in the detail drawings.
8. Install one valve per box where valves are installed in valve boxes.
9. Quick coupler valves shall be set approximately 12 inches from walks, curbs, header boards, or paved areas where applicable.

### M. Backflow Assemblies:

1. Install in shrub areas at minimum height permitted by local code and as detailed on Contract Documents.
2. Backflow unit shall be properly grounded.
3. Exact location of unit shall be approved by the Landscape Architect prior to installation.
4. Install on a concrete pad and inside of a vandal proof enclosure per the detail and manufacturer's recommendations.
5. The backflow prevention unit shall be installed in accordance with the requirements set forth by local codes.
  - a. Install backflow preventer unit as indicated in the detail Contract Documents.
  - b. Install backflow assemblies at locations approved in the field and at height required by local codes.
  - c. Install wye strainers and pressure regulators on the backflow assembly.
6. If backflow preventer is installed adjacent to a building, wall, or other obstruction, install unit so that the test cocks are facing outward away from the obstruction.

### N. Miscellaneous Equipment:

1. Install assemblies specified herein according to the respective detail drawings and specifications, using best standard practices.
2. Install devices such as rain sensors, freeze sensors, flush valves, and air relief valves, master valves and flow sensors as indicated on the Contract Documents and as recommended by the manufacturer.
3. Automatic Air Release Valve: Air release valves shall be installed at high points on the line per the direction and approval of the Landscape Architect. Install the air release valve in accordance with the manufacturers recommendations.
4. Automatic Flush Valve: The flush valve shall be installed per the irrigation details and manufacturer's recommendations.

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5. Disc Filter: The filter shall be installed in accordance with the irrigation details and manufacturer's recommendations.
6. Tree Irrigators: Locate at each tree. Install as indicated on Contract Documents, including vents, filters and other appurtenances.

### O. Drip Irrigation Specialty Installation

1. Install drip tubes below grade as indicated on the Contract Drawings.
2. Drip tubing shall be installed at a consistent depth and in parallel rows at the spacing indicated on the Contract Drawings.
3. Drip tubing shall be connected to the PVC supply and discharge headers as indicated on the Contract Drawings.
4. Drip tubing for trees shall be installed as indicated in the Contract Drawings and in spiral rings to cover the root ball and out into the emended and un-amended soils.
5. Additional emitters for vines shall be installed directly punched into the drip tubing as indicated on the Contract Drawings.
6. Install air relief valves and vacuum relief valves in piping, and in control-valve boxes.

## 3.06 UTILITY CONNECTIONS

- A. The irrigation subcontractor shall be responsible for the final electrical hook up to the irrigation controller.
- B. Connect to existing point of connection at locations indicated on Contract Documents and make minor changes in location necessary due to actual site conditions as work of this Section. Adapt to existing pipe using new couplers, and reducers.
- C. Connect to existing electrical service using necessary materials and connections as shown on the Contract Drawings. Make minor changes in location as necessary due to actual site conditions as work of this Section. Electrical work shall conform to local codes, ordinances and governing authorities. 120-volt power connection to controller shall be provided by the Contractor.

## 3.07 CONTROL WIRING

- A. Place wiring in the same trench and along the same routing as the pressure supply lines, unless otherwise indicated.
  1. Install wiring prior to main line whenever possible.
  2. Place wire at least 2-inches beside the piping.
  3. When more than one wire is placed in a trench, tape wires together at maximum 10 feet on centers, and lay to one side of trench.
  4. Lay control wire loosely in trench without stretching control wire conductors.
- B. Connections shall be of an approved type and shall occur in a valve box. Provide an 24 inch service loop at each connection.
- C. 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.
- D. Provide a 24-inch expansion loop at each connection and directional change, and a 24-inch expansion loop at each remote control valve.
  1. Provide a sufficient length at each splice to allow valve bonnet to be brought to the surface without disconnection.
- E. Run three spare No. 14 gage wires from controller along entirety of main line to last electric control valve each and every leg of main line. Label spare wires at both ends.

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- F. Under no circumstances shall splices be used without prior approval.
  - 1. If wires under paved areas cannot be continuous, splices shall be enclosed in a specified junction box set 1 inch above finish grade.
  - 2. Field splices between controller and remote control valve will not be permitted.
- G. Low Voltage:
  - 1. Pull boxes for the low voltage control wires shall be provided at a spacing of 500 feet on center along the wire route. An expansion loop of 24 inches shall be provided at each control wire pull box.

### 3.08 INSPECTION REQUIREMENTS

- A. Contractor shall permit Landscape Architect and Owner's authorized representative at times to visit and inspect the work and shall provide safe access for such visits.
- B. Where Specifications require work to be tested by Contractor, it shall not be concealed until accepted by the Landscape Architect, Owner's authorized representative, and/or governing agencies. Contractor shall be solely responsible for notifying Architect, Owner, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing. Should work be covered without testing or acceptance, it shall be, if so ordered, uncovered at Contractor's expense.
- C. Additional testing and inspection as required will be performed by inspector.
- D. Site observations and testing will not commence without the Project Record Drawings prepared by Contractor. Record Drawings must be complete and up to date for each site visit.
- E. Work that fails testing and is not accepted shall be retested. Hourly rates and expenses of the Landscape Architect, Owner's authorized representative, and governing agencies for reinspection or retesting will be paid by Contractor at no additional expense to Owner.
- F. Inspections by Architect's representative will be required for the following at a minimum:
  - 1. Coverage test of irrigation system. Test shall be performed prior to any planting.
  - 2. Final inspection prior to start of maintenance period
  - 3. Final acceptance

### 3.09 FIELD QUALITY CONTROL

- A. Contractor's Responsibility:
  - 1. Notify the Landscape Architect for the following reviews, with 48 hours minimum notice.
    - a. System layout.
    - b. Pressure supply line installation and testing.
    - c. Emitter tubing layout and emitter installation.
    - d. Coverage tests prior to landscape planting.
    - e. Automatic controller and backflow preventer/basket strainer installation.
    - f. Control wire installation.
      - 1) Contractor shall test wire for continuity, open circuits, and unintentional grounds prior to connecting to equipment or backfilling.
      - 2) Minimum insulation resistance to ground shall be 50 Megohms.
      - 3) Wiring not meeting this requirement shall be replaced at the Contractor's expense.
    - g. Lateral line and sprinkler head installation.
  - 2. Provide 7 days' notice for Final Review.

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3. Provide walkie-talkie equipment and personnel to maintain communication from review area to automatic controllers.
4. Provide up-to-date Project Record Drawings at each review.
  - a. In the event Contractor calls for a review without up-to-date Project Record Drawings, or without preparing the system for inspection, Contractor shall be responsible for reimbursing the Landscape Architect on an hourly basis for the inconvenience. No further review will be scheduled until this charge has been paid.
- B. Test systems prior to backfilling. If the only piping installed is over 20 feet long, pressure testing is required for that section at the time of installation. Upon completion of piping installation, the entire system shall be tested.
  1. Center load plastic pipe prior to pressure testing.
- C. 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.
- D. 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.
- E. When sprinkler system is completed, perform 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. This test shall be accepted by the Landscape Architect and accomplished before starting any planting.
- F. Furnish materials and perform 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 Contract 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.
- G. The final observation review will not commence without record drawings as prepared by the irrigation subcontractor.
- H. Permit the Landscape Architect and Owner's authorized representative to visit and observe at times any part of the work and shall provide safe access for such visits.
- I. Work to be tested shall not be covered over until reviewed and accepted by the Landscape Architect, Owner's authorized representative, and/or governing agencies. The irrigation subcontractor 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 irrigation subcontractor's expense.
- J. Site Observations Visits:
  1. Site observations visits will be required for the following at a minimum:
    - a. System layout.
    - b. Pressure test of irrigation main line (two hours at 125 PSI or 120% of static water pressure, whichever is greater.) Mainline pressure loss during test shall not exceed 2 PSI.
    - c. Coverage test of irrigation system. Tests shall be performed prior to any planting.
    - d. Final site observation prior to start of maintenance period.
    - e. Final acceptance.

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2. Site observations and testing will not commence without the record drawings as prepared by the irrigation subcontractor. Record drawings must be complete and up to date for each site visit.
- K. Water Analysis testing facility shall be Wallace Laboratories, El Segundo, CA (310)640-6863. Tests shall be paid for by the Contractor.
- L. Pressure Tests:
  1. Do not install remote control valves, quick couplers, or any other valve assembly until testing of pressure main lines is completed and approved.
  2. Do not backfill trenches more than necessary until testing has been reviewed, tested, and accepted.
  3. Provide equipment necessary to test systems, including force pump.
  4. Perform hydrostatic tests in presence of the Landscape Architect. No pipe shall be backfilled until it has been observed, tested, and approved in writing by the Landscape Architect. Should any work be covered up before such observation and tests are completed, the Contractor shall, at his own expense, uncover the work; and after it has been observed, tested and approved, he shall then make repairs with such materials as required to restore work disturbed to original and proper condition.
  5. Test pressure supply lines under hydrostatic pressure of 125 pounds per square inch for a period of not less than 2 hours, unless otherwise directed by Landscape Architect in writing. Place three pressure gauges, equally spaced, along mainline for review. Necessary pump equipment shall be present on site during the test.
- M. System Flushing: After sprinkler pipe lines and risers are in place and connected, and prior to installation of sprinkler heads, thoroughly flush lines with a full head of water. Install sprinkler heads after lines have been flushed to the satisfaction of the Landscape Architect.
  1. Prior to installation of sprinkler nozzles, the valves shall be opened and a full head of water used to flush out the lines and risers.
  2. Sprinkler nozzles shall be installed after flushing the system has been completed.
- N. Coverage Tests:
  1. Perform coverage tests after sprinkler system is completed, but prior to any planting, in the presence of the Landscape Architect.
  2. Test system to ensure that planting areas are watered adequately and uniformly.
  3. Make necessary adjustments, including realignment of heads, to provide required coverage as directed by the Landscape Architect.
  4. If it is determined that coverage can be improved by a nozzle change, make such changes, or arrange with the manufacturer to have such changes made, as part of the work of this Section. Make changes prior to any planting.
  5. Contractor shall operate each system in its entirety for the Landscape Architect at time of final observation. Items deemed not acceptable shall be reworked at no additional cost, to the complete satisfaction of the Landscape Architect.
- O. Work which 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 reinspection or retesting will be paid by the irrigation subcontractor at no additional expense to Owner.

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**3.10 ADJUSTING**

- A. Adjustment of the System
  - 1. Contractor shall adjust pressure regulating devices on the remote control valves as directed by the Landscape Architect.
  - 2. Contractor shall adjust and flush sprinklers for optimum performance and to prevent overspray onto walks, windows, roadways, and buildings as much as possible.
  - 3. If it is determined that adjustments in the irrigation equipment shall provide proper and more adequate coverage, the Contractor shall make such adjustments after written approval by the Landscape Architect. Adjustments shall include changes and additions of sprinklers, nozzle size and degrees of arc as required without additional contract costs. If found to be deficient, additional drip line may be required for full coverage.
  - 4. If it is determined that any irrigation equipment is improperly installed, then adjustments shall be made to conform to construction documents without additional contract costs.
  - 5. Sprinklers shall be set perpendicular to finished grades unless otherwise designated on the Contract Drawings of the Landscape Architect.
- B. Owner reserves the right to make temporary repairs as necessary to keep the irrigation system in operating condition. The exercise of this right shall not relieve the Contractor of his responsibilities under the terms of the guaranty as herein specified.
- C. Contractor shall adjust valves, align heads, and check coverage of each system prior to coverage test.
- D. 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, necessary changes or adjustments shall be made prior to any planting.
- E. The entire system shall be operating properly before any planting operations commence.
- F. Automatic control valves shall be adjusted so that the sprinkler heads operate at the pressure indicated on the Contract Drawings.

**3.11 CLEANING**

- A. Upon completion of the work, restore ground surfaces to required elevations and remove excess materials, debris, and equipment from the site.
- B. Clean-up shall be made as each portion of the work progresses. Refuse and excess dirt shall be removed from the site, walks and paving shall be broomed, and any damage sustained on the work of others shall be repaired to original conditions.
- C. 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.
- D. 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.

### **3.12 CLOSEOUT ACTIVITIES**

- A. Owner's Instruction: In accordance with Section 017823, provide instructions and demonstrations to Owner's maintenance personnel in proper operation of equipment
  - 1. At the time of the pre-maintenance period site observation visit, the Landscape Architect, Owner's authorized representative, and governing agencies will review the work, and if not accepted, will prepare a list of items to be completed by the Contractor. At the time of the post-maintenance period or final field observation visit the work will be reobserved and final acceptance will be in writing by the Landscape Architect, Owner's authorized representative, and governing agencies.
  - 2. The Owner's authorized representative shall have final authority on portions of the work.
  - 3. 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. Refer to Section 017823.

### **3.13 MAINTENANCE**

- A. Areas to be maintained for the maintenance period shall start maintenance at the same time, as directed by the Landscape Architect, Owner's authorized representative, 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 shall not be phased.
- B. Maintain the entire irrigation system under full automatic operation for a period of 7 days prior to any planting, and for 90 days after acceptance to begin maintenance period and in accordance with Section 320190.
- C. If, after maintenance review, irrigation systems are not acceptable to the Architect, Contractor shall reimburse the Landscape Architect for additional site visits and additional time required to review work. Additional time will be billed at the Architect's hourly rate and will be paid for by Contractor at no additional cost to the Owner.

### **END OF SECTION**

**SECTION 331100 – WATER UTILITY DISTRIBUTION PIPING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A Requirements: Provide water distribution system, complete, as indicated on the Drawings or inferable therefrom and/or as specified in accordance with the Contract Documents.

**1.02 SUBMITTALS**

- A Product Data: Submit copies of manufacturer's specifications and installation instructions for each material. Include certification or other data verifying compliance with required characteristics. Indicate by transmittal form that copy of each has been distributed to the Installer.
- B Shop Drawings: Submit layout and shop drawings as required under Section Submittals. Include details of reinforced concrete structures.
- C Test Reports: Submit certified Test Reports showing compliance of the following items in accordance with Section General Conditions.
  - 1. Laboratory test for bedding and trench stabilization materials.
  - 2. Concrete design mix.
  - 3. Compression tests.
  - 4. Water Test Reports: Submit results of water sample tests by State or local health authorities

**1.03 QUALITY ASSURANCE**

- A Regulatory Requirements:
  - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
  - 2. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
  - 3. The Contractor shall have one copy of the Standard Specifications at the job site.
  - 4. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.
- B Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- D NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- E NSF Compliance:
  - 1. Comply with NSF 14 for plastic potable-water-service piping.
  - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

**1.04 PROJECT CONDITIONS**

- A Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect not less than two days in advance of proposed utility interruptions.

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2. Do not proceed with utility interruptions without Architect's written permission.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A Prevent damage to materials during loading, transportation, and unloading. Store equipment with moving parts off ground on platforms or skids.

**1.06 COORDINATION**

- A Coordinate connection to water main with utility company.

**PART 2 PRODUCTS**

**2.01 MANUFACTURERS**

- A In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

**2.02 PIPE AND FITTINGS**

- A **Ductile-Iron Pipe (NPS 4 to NPS 12):** AWWA C151, [Class 350] with cement mortar lining complying with AWWA C104 and 1 mil thick bituminous coating.
  1. Fittings: Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts. Use corrosion resistant, high strength, low alloy steel, bolts and nuts where in contact with corrosive soil ASTM A 325.
  2. Fittings: Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern. Use corrosion resistant, high strength, low alloy steel, bolts and nuts where in contact with corrosive soil ASTM A 325.
    - a. Gaskets: AWWA C111, rubber.
- B **Copper Tube (NPS ¾ to NPS 3 ½):** ASTM B 88, Type K, water tube, annealed temper.
  1. Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- C **PVC, Schedule 40 (NPS 1/8 to NPS 3 ½):** ASTM D 1785. Suitable for potable water distribution and manufactured in compliance with NSF Standards.
  1. Fittings: PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- D **PVC, AWWA Pipe (NPS 4 to NPS 12):** AWWA C900, Class 305 DR 14, with bell-and-spigot or double-bell ends.
  1. PVC to PVC Fittings: Push-on-Joint, PVC Fittings, ASTM 3139, with elastomeric gasket bell ends, conforming to ASTM D2122 for bell measurements.
  2. PVC to Metal Fittings, Valves, and Accessories: Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

- a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts. Use corrosion resistant, high strength, low alloy steel, bolts and nuts where in contact with corrosive soil ASTM A 325.

## **2.03 VALVES**

### **A AWWA, UL/FM Cast-Iron, Gate Valves:**

1. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509 and UL/F.M. approved, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
  - a. Minimum Working Pressure: 200 pounds per square inch gauge (psig).
  - b. End Connections: Flanged, push-on rubber gasketed, or mechanical joint, as required.
  - c. Interior Coating: Complying with AWWA C550.

## **2.04 GATE VALVE ACCESSORIES AND SPECIALTIES**

- A Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over valve, and approximately **five-inch** diameter barrel. Fabricate valve box cover to fit snugly to prevent displacement by traffic.
  1. Operating Wrenches: Steel tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- B Vertical-Type Indicator Posts: UL 789, FM-approved, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve with tamperproof electrical supervisory switch for connection to the fire alarm control panel system.

## **2.05 VALVE APPLICATION**

- A General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
  1. Where specific valve types are not indicated, the following requirements apply:
    - a. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated, gate valves with valve box.
    - b. Underground Valves, NPS 4 and Larger, for Vertical-Type Indicator Posts: UL/FM, Cast-iron, nonrising-stem gate valves with indicator post.

## **2.06 CORROSION-PROTECTION ENCASEMENT FOR PIPING**

- A Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube, or sheet.

## **2.07 WATER METERS**

- A Water meter(s) indicated on drawings shall be installed by the local water purveyor for the area, unless noted otherwise.

## **2.08 BACKFLOW-PREVENTION DEVICES**

- A General: FM Approved, AWWA, UL Classified, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.
  1. Working Pressure: 175 pounds per square inch (psi) minimum, unless otherwise indicated.

2. Interior Components: Corrosion-resistant materials.
  3. Exterior Components: Assembly shall be provided with flanged connections, galvanized cast-iron or epoxy coated construction.
- B Reduced-Pressure-Detector Assembly Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet. Include test cocks; pressure-differential relief valve with ASME A112.1.2, air-gap fitting located between two positive-seating check valves; and bypass with displacement-type water meter, valves, and reduced-pressure backflow preventer. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.
- C Double-Check-Detector Assembly Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet. Include test cocks; two positive-seating check valves; and bypass with displacement-type water meter, valves, and double-check backflow preventer. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

## **2.09 FIRE HYDRANTS**

- A Before procurement, verify approval has been issued by the Fire Department having jurisdiction.
- B Wet-Barrel Fire Hydrants: AWWA C503 or UL 312, one NPS 4 and two NPS 2-1/2 outlets, NPS 6 threaded or flanged inlet, and base section with NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have 150 pounds per square inch gauge (psig) minimum working-pressure design.
1. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
  2. Operating and Cap Nuts: Pentagon, one-and-one-half inches point to flat.
  3. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
- C Combined length of bury and extension shall be as indicated. Where not indicated, install top of hydrant flange three inches above finished surface.
- D Exterior Finish: "O.S.H.A. safety yellow" Ameritone 719 or approved equal after receiving a prime coat.

## **2.10 FIRE DEPARTMENT CONNECTIONS.**

- A Exposed, Freestanding, Fire Department Connections: UL 405, cast-bronze body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch high brass sleeve; and round escutcheon plate, and all appropriate check valves per NFPA 24.
1. Escutcheon Plate Marking: "[**AUTO SPKR**]."

## **PART 3 EXECUTION**

### **3.01 INSPECTION**

- A Examination: Examine substrates, adjoining construction and conditions under which Work is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected

### **3.02 PREPARATION**

- A Field Measurements: Verify dimensions before proceeding with Work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for accuracy of such measurements and precise fitting and assembly of finished work.

**3.03 JOINT CONSTRUCTION**

- A Make pipe joints according to the following:
  - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
  - 3. Copper Tubing Soldered Joints: ASTM B 828. Use flushable flux and lead-free solder.
  - 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
  - 5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

**3.04 PIPING INSTALLATION**

- A Project site water lines shall terminate approximately five feet from buildings, unless otherwise indicated on Drawings. Install temporary cap or plug terminals for future connection to building.
- B Bury piping with depth of cover over top at least 36 inches, unless otherwise indicated.
- C Comply with NFPA 24 for fire-service-main piping materials and installation.
- D Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- E Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- F Install PVC, AWWA pipe according to AWWA M23 and ASTM F 645.
- G Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports for all lines NPS 3 or greater.
- H Water Main Connection: Arrange and pay for tap in the water main, water meter, and all associated fees from the water purveyor.

**3.05 CLEARANCE OF WATER LINE**

- A Building or Structure: Two feet minimum horizontal separation.
- B Sewer crossing:
  - 1. Typical Conditions: Lay water mains over sanitary sewers to provide vertical separation minimum three feet.
  - 2. Unusual Conditions: If above separation cannot be met, for sewers less than three feet below the water pipe, use the following:
    - a. Install water line with all joints located at least four feet from each side of the sewer pipe.
    - b. Sewer pipe encased in six inches concrete around pipe, and extend four feet either side of water main.
- C Parallel to Sewer Line: Water line shall not be installed in a common trench with the building sanitary sewer unless both of the following requirements are met:
  - 1. The bottom of the water pipe, at all points, shall be at least 12 inches above the top of the sewer.
  - 2. The water pipe shall be placed on a solid shelf excavated at one side of the common trench with a minimum clear horizontal distance of at least 12 inches from the sewer.



**3.06 ANCHORAGE INSTALLATION**

- A Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches for all lines NPS 3 or greater. Include anchorages for the following piping systems:
1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
  3. Fire-Service-Main Piping: According to NFPA 24.
  4. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

**3.07 VALVE INSTALLATION**

- A Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B Vertical-Type Indicator Post Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

**3.08 BACKFLOW-PREVENTER INSTALLATION**

- A Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B Do not install backflow preventers with relief drain in vault or other space subject to flooding.
- C Do not install bypass piping around backflow preventers.
- D Support three-inch and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.
- E Access and clearance shall be provided for the required testing, maintenance and repair. Access and clearance shall require a minimum of one foot between the lowest portion of the assembly and grade or platform.
- F Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

**3.09 FIRE HYDRANT INSTALLATION**

- A General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B UL/FM-Type Fire Hydrants: Comply with NFPA 24.

**3.10 FIRE DEPARTMENT CONNECTION INSTALLATION**

- A Install fire department connections of types and features indicated.
- B Install ball drip valves at each check valve for fire department connection to mains.

**3.11 IDENTIFICATION**

- A Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for tape specifications.

**3.12 FIELD QUALITY CONTROL**

- A Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

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- B Hydrostatic Tests: The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than 150 pounds per square inch (psi). Examine all exposed pipe, joints, fittings and accessories during the test period. Replace or repair defective portions of the system, and repeat tests until results are satisfactory.

1. Allowable leakage shall be as specified in AWWA C-600, Table 3.

- C Prepare reports of testing activities.

### 3.13

#### **CLEANING**

- A Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:
  - a. Fill system or part of system with water/chlorine solution containing at least 50 parts per million (ppm) of chlorine; isolate and allow to stand for 24 hours, or
  - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 parts per million (ppm) of chlorine; isolate and allow to stand for three hours.
  - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

- B Prepare reports of purging and disinfecting activities.

**END OF SECTION**

**WATER UTILITY DISTRIBUTION PIPING - 331100**

## SECTION 333100 – SANITARY UTILITY SEWERAGE PIPING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
  - 1. Cleanouts.
  - 2. Precast concrete manholes.

#### 1.02 PERFORMANCE REQUIREMENTS

- A Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

#### 1.03 SUBMITTALS

- A Manufacturer's product data for pipe and fittings.
- B Field quality-control test reports.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

#### 2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A Pipe and Fittings: ASTM A 74, Service class.
- B Gaskets: ASTM C 564, rubber.
- C Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

#### 2.03 PVC PIPE AND FITTINGS

- A PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

#### 2.04 NONPRESSURE-TYPE PIPE COUPLINGS

- A Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B Sleeve Materials:
  - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
  - 2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

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## 2.05 MANHOLES

- A Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Diameter: Forty-eight inches, unless otherwise indicated.
  2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  3. Base Section: Six-inch minimum thickness for floor slab and four-inch (100-mm) minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
  4. Riser Sections: Four-inch minimum thickness, and of length to provide depth indicated.
  5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
  8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, one-half-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
  9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
  10. Grade Rings: Reinforced concrete rings, six- to nine-inch total thickness, to match diameter of manhole frame and cover.
  11. Manhole Frames and Covers: Ferrous; 24-inch ID by seven- to nine-inch riser with four-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording "SANITARY SEWER."
    - a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48/A 48M, Class 35 gray iron, unless otherwise indicated.

## 2.06 CLEANOUTS

- A Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
1. Top-Loading Classification: Heavy duty.
  2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

## 2.07 CONCRETE

- A General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
  2. Fine Aggregate: ASTM C 33, sand.
  3. Coarse Aggregate: ASTM C 33, crushed gravel.
  4. Water: Potable.

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- B Portland Cement Design Mix: 3,250 pounds per square inch (psi) minimum unless otherwise noted, Aggregate Gradation "C" per SSPWC 201-1.3.2 and 0.45 maximum water/cementitious materials ratio.
  - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
  - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - a. Invert Slope: Two percent through manhole unless otherwise noted.
  - 2. Benches: Concrete, sloped to drain into channel.
    - a. Slope: Four percent.
- D Ballast and Pipe Supports: Portland cement design mix, 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio.
  - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

### 2.08 CORROSION-PROTECTION ENCASEMENT FOR PIPING

- A Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube, or sheet.

## PART 3 EXECUTION

### 3.01 PIPING APPLICATIONS

- A Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
  - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
    - a. Shielded flexible couplings for same or minor difference OD pipes.
    - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

### 3.02 PIPING INSTALLATION

- A Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- B Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- C Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D Install gravity-flow, nonpressure, drainage piping according to the following:

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1. Install piping pitched down in direction of flow, at minimum slope of one percent, unless otherwise indicated.
  2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- E Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

**3.03 PIPE JOINT CONSTRUCTION**

- A Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
  3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
  4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
  5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

**3.04 MANHOLE INSTALLATION**

- A General: Install manholes complete with appurtenances and accessories indicated.
- B Install precast concrete manhole sections with sealants according to ASTM C 891.
- C Form continuous concrete channels and benches between inlets and outlet.
- D Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops three inches above finished surface elsewhere, unless otherwise indicated.

**3.05 CONNECTIONS**

- A Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."
- B Make connections to existing piping and underground manholes.
1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus six-inch overlap, with not less than six inches of concrete with 28-day compressive strength of 3,250 pounds per square inch (psi).

**3.06 FIELD QUALITY CONTROL**

- A Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
  2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
  4. Submit separate report for each test.
  5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

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- a. Allowable leakage is maximum of 50 gallons/inch of nominal pipe size per mile of pipe, during 24-hour period.
- b. Close openings in system and fill with water.
- c. Purge air and refill with water.
- d. Disconnect water supply.
- e. Test and inspect joints for leaks.
- f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 pounds per square inch gauge (psig).
- 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
  - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- B Leaks and loss in test pressure constitute defects that must be repaired.
- C Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

**END OF SECTION**

**SANITARY UTILITY SEWERAGE PIPING - 333100**

## SECTION 334100 – STORM UTILITY DRAINAGE PIPING

### PART 1 GENERAL

#### 1.01 ARTICLE

##### 1.02 SUMMARY

- A This Section includes gravity-flow, nonpressure storm drainage pipe and drainage structures outside the building.

##### 1.03 PERFORMANCE REQUIREMENTS

- A Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

##### 1.04 SUBMITTALS

- A Product Data: For each type of product installed.
- B Field quality-control test reports.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

#### 2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A Pipe and Fittings: ASTM A 74, Service class.
- B Gaskets: ASTM C 564, rubber.
- C Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

#### 2.03 CORRUGATED HIGH DENSITY POLYETHYLENE (HDPE) HDPE PIPE AND FITTINGS

- A HDPE Drainage Pipe and Fittings, NPS 4 to NPS 10: AASHTO M252, Type S, with bell-and-spigot ends. Gasketed joints shall be soil-tight with ASTM F 477, elastomeric seals.
- B HDPE Drainage Pipe and Fittings, NPS 12 to NPS 60: AASHTO M294, Type S, or ASTM F2306 with bell-and-spigot ends. Gasketed joints shall be soil-tight with ASTM F 477, elastomeric seal.

#### 2.04 PVC PIPE AND FITTINGS

- A PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- B PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

#### 2.05 NONPRESSURE-TYPE PIPE COUPLINGS

- A Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B Sleeve Materials:
  - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
  - 2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

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3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

### 2.06 CLEANOUTS

- A PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

### 2.07 MANHOLES

- A Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  1. Diameter: Forty-eight inches minimum, unless otherwise indicated.
  2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  3. Base Section: Six-inch minimum thickness for floor slab and four-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  4. Riser Sections: Four-inch minimum thickness, and of length to provide depth indicated.
  5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  6. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
  7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
  8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, one-half-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
  9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
  10. Grade Rings: Reinforced-concrete rings, six- to nine-inch total thickness, to match diameter of manhole frame and cover.
  11. Manhole Frames and Covers: Ferrous; 24-inch ID by seven- to nine-inch riser with four-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording "STORM DRAIN."
    - a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48, Class 35 gray iron, unless otherwise indicated.

### 2.08 CONCRETE

- A General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
  1. Cement: ASTM C 150, Type II.
  2. Fine Aggregate: ASTM C 33, sand.
  3. Coarse Aggregate: ASTM C 33, crushed gravel.

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4. Water: Potable.
5. Pipe Collars, Ballast and Pipe Supports, Precast Manhole Components, Catch Basins, and Sidewalk Culverts: Portland cement design mix, 3,250 pounds per square inch (psi) minimum unless otherwise noted, Aggregate Gradation "C" per SSPWC 201-1.3.2, and with 0.45 maximum water-cementitious materials ratio.
  - a. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - b. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

**2.09 CATCH BASINS**

- A Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  1. Base Section: Six-inch minimum thickness for floor slab and four-inch minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
  2. Top Section: Eccentric-cone type unless flat-slab-top type is indicated.
  3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
- B Frames and Grates: [ENGINEER TO MODIFY BELOW REQUIREMENTS AS NECESSARY]
  1. ASTM A 536, Grade 60-40-18, ductile iron designed for A-16 (heavy traffic) structural loading unless otherwise indicated in plans.
  2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.
  3. Compliant with Americans with Disabilities Act (ADA).
  4. Heelproof.
  5. Grate size as indicated per plans.
  6. Risers shall be seven inches to nine inches tall with four-inch minimum width flange.

**PART 3 EXECUTION**

**3.01 PIPING APPLICATIONS**

- A Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
  1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
    - a. Shielded flexible couplings for same or minor difference OD pipes.
    - b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

**3.02 PIPING INSTALLATION**

- A Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- B Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections unless direct tap into existing storm drain is indicated.
- C Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D Install gravity-flow, nonpressure drainage piping according to the following:

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1. Install piping pitched down in direction of flow, at minimum slope of one percent, unless otherwise indicated.
2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

E Clear interior of piping and manholes of dirt and superfluous material as work progresses.

### 3.03 PIPE JOINT CONSTRUCTION

A Join gravity-flow, nonpressure drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

### 3.04 MANHOLE INSTALLATION

A General: Install manholes, complete with appurtenances and accessories indicated.

B Install precast concrete manhole sections with sealants according to ASTM C 891.

C Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops three inches above finished surface elsewhere, unless otherwise indicated.

### 3.05 CATCH BASIN INSTALLATION

A Set frames and grates to elevations indicated.

B Provide storm drain piping connections to catch basins as indicated in the project drawings. Storm drain connections shall be to the catch basin side wall, not base.

### 3.06 CONNECTIONS

A Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus six-inch overlap, with not less than six inches of concrete with 28-day compressive strength of 3,250 pounds per square inch (psi).

### 3.07 LOW IMPACT DEVELOPMENT STORM WATER MITIGATION SYSTEMS INSTALLATION

A All storm water mitigation systems proposed as a part of this project, and as approved by the local jurisdiction, are to be inspected by the Civil Engineer of Record during the installation process, after installation is complete, and prior to obtaining a certificate of occupancy.

1. Notify the Civil Engineer of Record at least 24-48 hours prior to the following (minimum) stages, in addition to those noted above, for inspection purposes:
  - a. Excavation for system installation.
  - b. Placement of gravel fills, system liners, piping, inlet and overflow piping, soil backfill, and planting where required.

### 3.08 FIELD QUALITY CONTROL

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- A Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.
  - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
  - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - 4. Submit separate report for each test.
  - 5. Hydrostatic Tests: Test sewers according to requirements of authorities having jurisdiction and the following:
    - a. Allowable leakage is maximum of 50 gallons/inch of nominal pipe size per mile of pipe, during 24-hour period.
    - b. Close openings in system and fill with water.
    - c. Purge air and refill with water.
    - d. Disconnect water supply.
    - e. Test and inspect joints for leaks.
  - 6. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 pounds per square inch gauge (psig).
  - 7. Air Tests: Test storm drainage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- B Leaks and loss in test pressure constitute defects that must be repaired.
- C Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

**END OF SECTION**

**STORM UTILITY DRAINAGE PIPING - 334100**

## SECTION 334600 - SUBDRAINAGE

### PART 1 GENERAL

#### 1.01 SUMMARY

- A This Section includes subdrainage systems for foundations, underslab areas, retaining walls, and other subdrainage systems.

#### 1.02 SUBMITTALS

- A Product Data: For perforated pipe, fitting and drainage panel.

### PART 2 PRODUCTS

#### 2.01 PERFORATED-WALL PIPES AND FITTINGS

- A Perforated plastic pipe shall be either smooth-wall polyvinyl chloride plastic pipe, corrugated polyvinyl chloride plastic pipe with a smooth interior surface, or corrugated polyethylene plastic tubing.
1. Smooth-wall polyvinyl chloride plastic pipe shall conform to the requirements in AASHTO Designation: M 278.
  2. Corrugated polyvinyl chloride plastic pipe with a smooth interior surface shall conform to the material and structural requirements in AASHTO Designation: M 278. The pipe shall have perforations located in the bottom half of the pipe, and the perforations shall consist of slots meeting the size and opening area requirements in AASHTO Designation: M 252. The inside diameter and diameter tolerances shall conform to the requirements of either AASHTO Designation: M 252 or M 278.
  3. Corrugated polyethylene plastic tubing shall conform to the requirements in AASHTO Designation: M 252 or M 294.

#### 2.02 PERFORATIONS

- A Perforations per ASTM F 758, section 7.2.4., and Table 5.
1. NPS 4: **[two rows] [four rows]** of perforations.
  2. NPS 6 and 8: Four rows of perforations
  3. NPS 10 and larger: Six rows of perforations.

#### 2.03 FITTINGS

- A Polyvinyl chloride pipe shall be connected with belled ends, or with sleeve-type or stop-type couplings conforming to the requirements in AASHTO Designation: M 278. Polyethylene tubing shall be connected with snap-on, screw-on, or wrap-around fittings and couplings conforming to the requirements of AASHTO Designation: M 252 or M 294. Solvent cementing of joints will not be required.

#### 2.04 SPECIAL PIPE COUPLINGS

- A Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
1. **[Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant metal tension band and tightening mechanism on each end.]**

2. **[Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.]**

## **2.05 DRAINAGE PANELS**

- A Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches wide with drainage core faced with geotextile filter fabric.
  1. Manufacturers:
    - a. **American Wick Drain Corporation – Amerdrain.**
    - b. Cosella-Dorken.
    - c. **CCW – MiraDrain.**
    - d. Eljen Corp.
    - e. Greenstreak, Inc.
    - f. JDR Enterprises, Inc.
    - g. LINQ Industrial Fabrics, Inc.
    - h. Midwest Diversified Technologies Incorporated.
    - i. TC Mirafi.
    - j. Any equivalent manufacturer.
  2. **Prefabricated Drainage Core:** Three-dimensional, nonbiodegradable, molded PP or PS. **Select prefabricated drainage core recommended by the manufacturer for the type of application specified elsewhere in the contract documents.**
    - a. Minimum Compressive Strength: 10,000-pound force (lbf)/square foot according to ASTM D 1621.
    - b. Minimum In-Plane Flow Rate: Ten gallons per minute (gpm)/foot **according to ASTM D-4716.**
  3. **Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties:**
    - a. **Grab Elongation: 60 percent maximum according to ASTM D-4632.**
    - b. **Apparent Opening Size: No. 70 sieve, minimum according to ASTM D-4751.**
    - c. **Water Flow Rate: 165 gpm/square foot according to ASTM D-4491.**

## **2.06 SOIL MATERIALS**

- A Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

## **2.07 GEOTEXTILE FILTER FABRICS**

- A Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gallons per minute (gpm)/square foot when tested according to ASTM D 4491.
  1. Structure Type: Nonwoven, needle-punched continuous filament or woven, monofilament or multifilament.
  2. Style(s): Flat and sock.

## **PART 3 EXECUTION**

### **3.01 EARTHWORK**

- A Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

**3.02 PIPING APPLICATIONS**

- A Underground Subdrainage Piping:
  - 1. Perforated PE pipe and fittings, couplings, and coupled joints.
  - 2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.
- B Underslab Subdrainage Piping:
  - 1. Perforated PE pipe and fittings, couplings, and coupled joints.
  - 2. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.
- C Header Piping:
  - 1. **PE drainage tubing and fittings, couplings, and coupled joints.**
  - 2. **PVC sewer pipe and fittings, couplings, and coupled joints.**

**3.03 FOUNDATION DRAINAGE INSTALLATION**

- A **Install vertical drainage panels per manufacturer's installation instruction and details or as follows:**
  - 1. Coordinate placement with other drainage materials.
  - 2. Separate four inches of fabric at beginning of roll and cut away four inches of core. Wrap fabric around end of remaining core.
  - 3. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from two to six inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stickpins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
  - 4. If additional panels are required on same row, cut away four inches of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
  - 5. If additional rows of panels are required, overlap lower panel with four inches of fabric.
  - 6. Cut panel as necessary to keep top 12 inches below finish grade.
  - 7. For inside corners, bend panel. For outside corners, cut core to provide three inches for overlap.
- B Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding six inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

**3.04 PIPING INSTALLATION**

- A Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - 1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
  - 2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
  - 3. Lay perforated pipe with perforations down.
  - 4. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

- B Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C Install PE piping according to ASTM D 2321.
- D Install PVC piping according to ASTM D 2321.

**3.05 PIPE JOINT CONSTRUCTION**

- A Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."
- B Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
- C Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.
- D Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.
- E Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

**3.06 CONNECTIONS**

- A Drawings indicate general arrangement of piping, fittings, and specialties..
- B Connect low elevations of subdrainage system to[ **building's**] solid-wall-piping storm drainage system.
- C Where required, connect low elevations of foundation or underslab subdrainage to storm water sump pumps.

**3.07 FIELD QUALITY CONTROL.**

- A Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

**3.08 CLEANING**

- A Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

**END OF SECTION**